NEW SERIES

SELECTED

SESOURCESABSTRACTS



VOLUME 1, NUMBER 11A NOVEMBER 1, 1968

NEW SERIES

Selected Water Resources Abstracts is published semimonthly for the Water Resources Scientific Information Center (WRSIC) by the Clearinghouse for Federal Scientific and Technical Information (CFSTI) of the Bureau of Standards, U. S. Department of Commerce. It is available to Federal agencies, contractors, or grantees in water resources upon request to: Manager, Water Resources Scientific Information Center, Office of Water Resources Research, U. S. Department of the Interior, Washington, D. C. 20240.



SELECTED

WATER RESOURCES ABSTRACTS

A Semimonthly Publication of the Water Resources Scientific Information Center, Office of Water Resources Research, U.S. Department of the Interior



VOLUME 1, NUMBER 11A

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UNITED STATES DEPARTMENT OF THE INTERIOR

STEWART L. UDALL, Secretary

OFFICE OF WATER RESOURCES RESEARCH

Roland R. Renne, Director

WATER RESOURCES SCIENTIFIC INFORMATION CENTER

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FOREWORD

Selected Water Resources Abstracts, a semimonthly journal, includes abstracts of current and earlier pertinent monographs, journal articles, reports, and other publication formats. The contents of these documents cover the water-related aspects of the life, physical, and social sciences as well as related engineering and legal aspects of the characteristics, conservation, control, use, or management of water. Each abstract includes a full bibliographical citation and a set of descriptors or identifers which are listed in the **Water Resources Thesaurus** (November 1966 edition). Each abstract entry is classified into ten fields and sixty groups similar to the water resources research categories established by the Committee on Water Resources Research of the Federal Council for Science and Technology.

Sufficient bibliographic information is given to enable readers to order the desired documents from local libraries or other sources. WRSIC is not presently prepared to furnish loan or retention copies of the publications announced.

Selected Water Resources Abstracts is designed to serve the scientific and technical information needs of scientists, engineers, and managers as one of several planned services of the Water Resources Scientific Information Center (WRSIC). The Center was established by the Secretary of the Interior and has been designated by the Federal Council for Science and Technology to serve the water resources community by improving the communication of water-related research results. The Center is pursuing this objective by coordinating and supplementing the existing scientific and technical information activities associated with active research and investigation program in water resources.

To provide WRSIC with input, selected organizations with active water resources research programs are supported as "centers of competence" responsible for selecting, abstracting, and indexing from the current and earlier pertinent literature in specified subject areas. Centers, and their subject coverage, now in operation are:

- Ground and surface water hydrology at the Water Resources Division of the U.S. Geological Survey, U.S. Department of the Interior.
- Metropolitan water resources management at the Center for Urban Studies of the University of Chicago.
- Eastern United States water law at the College of Law of the University of Florida.
- Policy models of water resources systems at the Department of Water Resources Engineering of Cornell University.
- Water resources economics at the Water Resources Research Institute of Rutgers University.
- Eutrophication at the Water Resources Center of the University of Wisconsin.
- Water resources of arid lands at the Office of Arid Lands Studies of the University of Arizona.

The input from these Centers, and from the 51 Water Resources Research Institutes administered under the Water Resources Research Act of 1964, as well as input from the grantees and contractors of the Office of Water Resources Research and other Federal water resources agencies with which the Center has agreements becomes the information base from which this journal is, and other information services will be, derived; these services include bibliographies, specialized indexes, literature searches, and state-of-the-art reviews.

Comments and suggestions concerning the contents and arrangement of this bulletin are welcome.

Water Resources Scientific
Information Center
Office of Water Resources Research
U.S. Department of the Interior
Washington, D. C. 20240

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02 WATER CYCLE

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05 WATER QUALITY MANAGEMENT AND PROTECTION

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06 WATER RESOURCES PLANNING

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SELECTED WATER RESOURCES ABSTRACTS

01. NATURE OF WATER

1A. Properties

THE THEORY OF ARTIFICIAL SEICHES, Cambridge Univ., Trinity College, Great Britain, Engineering Laboratory. For primary bibliographic entry see Field 08B. For abstract, see.

W68-00945

SEICHES AND SET-UP ON LAKE WINNIPEG, Dept. of Transport, Winnipeg, Manitoba, Prairie Weather Central

For primary bibliographic entry see Field 08B. For abstract, see

W68-00952

02. WATER CYCLE

2A. General

FACTOR ANALYSIS IN HYDROLOGY--AN AGNOSTIC VIEW, IBM Watson Research Center, Yorktown Heights,

James R. Wallis.

Water Resources Res, Vol 4, No 3, pp 521-527, June 1968. 7 p, 3 tab, 23 ref.

Descriptors: *Forecasting, Regression analysis,

Model studies Identifiers: *Factor analysis, *Antifactor analysis prediction problems, Reduced rank regression.

A new procedure is recommended for use in hydrologic analysis. 'Antifactor analysis,' resulting from work done with reduced rank regression prediction, is defined as a useful tool for certain types of hydrologic research. Antifactor analysis is a numerical screening and modeling procedure based on criteria and expectations different from classical factor analysis. Classical factor analysis is not confactor analysis. Classical factor analysis is not considered useful in hydrologic studies since in hydrology there are rarely large samples taken from a homogeneous population. Furthermore, measurement errors on hydrologic variables tend to be much smaller than those in typical psychometric studies. To make classical factor analysis work with hydrologic data, it is necessary either to define the factors in nonmetric terms or to define the factors in terms of the variables and accept the idea that factorial invariance cannot be obtained. Antifactor analysis can be used in solving complex prediction problems. (Llaverias-USGS) W68-00669

LAND FORMS, WATER AND LAND USE WEST OF THE INDUS PLAIN, International Training Centre for Aerial Survey,

Delft, Netherlands. H. Th. Verstappen. Nature and Resources, Vol 2, No 3, pp 6-8, Sept 1966. 3 p.

Descriptors: *Geomorphology, *Water utilization, Arid lands, *Land use, Irrigation water, *Hydrological properties, Rainfall-runoff relationships, Surical properties, Kainfall-runoff relationships, Surface-groundwater relationships, Flood irrigation, Petrography, Rainfall intensity, Rainfall disposition, Irrigation practices, Watersheds (Basins), Limestone, Bypasses, Gravels, Shales. Identifiers: Mudstones, Indus Plain, West Pakistan, Fans (Geology), Karezes.

Due to wide range in lithological conditions and in annual rainfall, there is great variety in hydrological characteristics of various drainage basins. Moderate intensity and fairly reliable winter rains fall in river basins of limestone which may have an average superficial run-off of only 5%. Summer rains, which are erratic and fall in heavy showers, are found in areas of shale and mudstone which

may yield run-off of 70-90%. Gravel fans are important in obtaining ground and surface water for irrigation. Temporary dams were built in the river bed to divert flood water for field irrigation. Climatic changes of the past, through the hydrological and geomorphological changes which it produced, still influence distribution of agricultural activities in the plain. The survey carried out in the Porali Plain revealed complex relations between geomorphology, ground- and surface-water conditions and agricultural land use in the dry mountainous areas west of the Indus Valley. (Blecker-Ariz.) W68-00695

RAINFALL EFFECTS ON SOIL SURFACE CHARACTERISTICS FOLLOWING RANGE IM-PROVEMENT TREATMENTS.

S. Department of Agriculture, Agricultural Research Service, Southwest Watershed Research

Center, Tucson, Arizona.
David R. Kincaid, and Gerald Williams.
J Range Manag, Vol 19, No 6, pp 346-351, Nov 1966. 6 p, 1 fig. 4 tab.

Descriptors: *Soil surfaces, *Rainfall, *Range management, Summer, Planting management, *Rainfall-runoff relationships, Rainfall intensity, *Surface runoff, *Thunderstorms, *Soil stability, Brush control, Cover crops, Vegetation effects, Soil treatment, Erosion control. Identifiers: Pitting, Crown cover.

The principle objective of this study is to investigate changes in soil surface resulting from one summer's rainy season following brush removal, pitting, seeding and a combination of these treat-ments. The study area was within Walnut Gulch Experimental Watershed, Tombstone, Ariz. Average annual precipitation is approximately 14 in, of which 60% falls during convectional thunderstorms in July, August and September. The soil is a gravelly sandy loam. One season's data on surface runoff showed little correlation between runoff and treatment. Reduced runoff seemed to be related to pitting treatment in the earlier summer storms, but later in summer pitting was related to increased runoff. Response varied from statistically nonsignificant changes in untreated, seeded, and cleared and seeded plots to statistically highly sig-nificant changes in plots of the other treatments. At the end of the summer rains, seeding alone, and in all combinations of treatments, was accompanied by statistically significant decrease in litter. Generally the lower half of the plots underwent more erosion than the upper half. Crown cover appeared to have a greater effect in reducing rainsite runnoff than did soil treatments. (Blecker-Ariz)

A TEST OF THE TOPOLOGICAL STRUCTURE

OF RIVER NETS, Illinois, Univ., Urbana, Illinois. G. Ranalli, and A. E. Scheidegger. Bull Int Ass Sci Hydrol, Vol 13, No 2, pp 142-153, June 1968. 12 pp, 4 fig, 4 tab, 12 ref.

Descriptors: *River systems, *Synthetic hydrology, *Geomorphology *Mathematical models. *Mathematical models, *Tributaries, *Geomorphology, *Mathematical *Stochastic processes, Networks, Drainage systems, Regression analysis. Identifiers: *Topology (Stream systems), *Horton net, *Graph theory, Random junctions, Stream cy-cles, Wabash River, Stream order.

Two basically different models were proposed in order to give a rational explanation of Horton's law of stream numbers: the 'cyclic' model and the 'ran-dom graph' model. In the cyclic model, a Horton net' must be Hortonian in all its parts, and there-fore channels of different (Strahler) order must be hierarchically arranged to form successive 'genera-tions' of rivers; in the random graph model, chan-nels join in a completely random fashion, and a 'Horton net' is simply a net in which Horton's law of stream numbers is numerically satisfied. In the present paper, these 2 models were tested on a large stream population: the Wabash river system, in the continental U.S.A. This network is Hortonian, since the law of stream numbers is numerically satisfied with little scatter; but it shows no structural regularity at all. This seems to be a fairly general case. Therefore, the concept of structural regularity does not have its counterpart in nature; accordingly, the cyclic model does not correspond to reality. The random graph model, on the contra-ry, explains very well the observed facts: its basic statistical assumption, moreover, is found to be in agreement with observation. (Knapp-USGS) W 68-00840

COMPUTATION OF OPTIMUM REALIZABLE UNIT HYDROGRAPHS.

Massachusetts Institute of Technology, Cambridge; Univ Nacional de Colombia, Medellin.

Peter S. Eagleson, Ricardo Mejia-R, and Frederic March

Water resources Res, Vol 2, No 4, pp 755-764, Fourth Quart 1966. 10 p, 6 fig, 22 ref.

Descriptors: *Unit hydrographs, Optimization, Rainfall-runoff relationships, *Linear programming, Least squares method. Identifiers: Weiner-Hopf theory.

The Wiener-Hopf theory of optimum linear systems was applied to the determination of a stable, monotone hydrologic system using input-output analysis. This resulted in a set of linear programming, an approximate solution to these equations was obtained, resulting in hydrologically feasible (positive ordinates unit hydrographs). (Gablinger-Cornell) W68-00874

LINEAR SYSTEM ANALYSIS IN SURFACE HYDROLOGY AND ITS APPLICATION TO INDIANA WATERSHEDS,

Purdue Univ., Lafayette, Indiana. D Blank Ph.D. Thesis, Purdue University.

Descriptors: System analysis, Input-output analysis, *Hydrograph analysis, *Rainfall-runoff relationships, *Watersheds, Base runoff, Rainfall excess, Storm runoff, Harmonic analysis, Frequency analy-

sis, Hydrologic models, Synthetic hydrology, Analog models. Identifiers: Linear system, Impulsive response, Convolution integral, Laplace transform, Fourier transform, Input matrix, Output vector, Kernel vec-

Rainfall-runoff relation were expressed by the convolution integral. The kernel function was evaluated by Fourier transform, Laplace-Gamma and Direct methods. Three analytical examples (known kernels) were analyzed. Date of 1059 storms from 55 Indiana watersheds ranging from 3 to 296 sq. mi. were assembled. The results indicated that for a third of the storms oscillatory kernels resulted. Oscillations were not necessarily due to nonlinearities but can arise from random errors in the data. Regardless of the shape of the kernel, output reproduction was accurate. Kernels from a watershed varied from storm to storm. These differences can be described in terms of time lag and maximum ordinate, and are indicative of system nonlinearity. Grouping of dimensionless kernels according to the above mentioned parameters is the basis for a suggested method of prediction, using trend relationships between maximum ordinate and base time, and between the former and time lag. Harmonic analysis of stage recorder response was presented, with the conclusion that for all natural storms no significant signal deformation is expected. Design and construction of an electronic analog simulator for rainfall-runoff studies were described. Preliminary investigation indicated that the analog is linear and be used to estimate response to natural storms. (Author) W68-00907

Group 2A—General

FLOAT TYPE STAGE RESPONSE OF RECORDER SYSTEMS, Purdue Univ., Lafayette, Indiana.

J. W. Delleur, and D. Blank.

Proceedings, the International Hydrology Symposium, Colorado State University, Fort Collins, Colorado, Vol. 1, pp 165-172, September 1967.

Descriptors: Harmonic analysis, Frequency analysis, *Floats.

Identifiers: Stage recorder, Sonic transducer.

A watershed may be analyzed as a hydrologic system, considering the rainfall excess as the input and the direct runoff as the output. The analysis of the watershed response is in turn dependent on the response of the measuring devices. The frequency response and the phase distortion of the measuring equipment are needed in the evaluation of the hydrologic system performance. This information is of particular importance in urban watersheds because their drainage areas are usually small and the time elements are often very short. For the above purpose, a float type stage recorder was installed above an oscillating tank used for generating the water level fluctuations. The tank can be subjected to a vertical harmonic motion with amplitudes ranging from 4 to 10 inches and frequencies 2 to 15 cycles per minute. The dynamic equations of motion of the float are developed with and without taking into account the influence of the friction forces. The motion of the water surface as recorded by a sonic transducer was compared with the motion of the float as obtained from the stage recorder. The results indicate that the float follows the motion of the surface of the water very closely, and that, within the amplitude and frequency range tested, there is no significant signal deformation. (Author) W68-00908

A MOISTURE-BALANCE PROFILE ON THE SIERRA NEVADA, Nevada Univ., Reno, Desert Research Institute. Charles F. Armstrong, and Charles K. Stidd. J Hydrol, Vol 5, No 3, pp 258-268, Sept 1967. 11 p, 7 fig, 3 ref.

Descriptors: *Precipitation (Atmospheric), *Climatology, *Orography, *Water balance, *Interception, Rain, Snow, Hydrologic cycle, Moisture, Precipitation gages, Runoff, Mountains, Stream

Identifiers: *Precipitation distribution in mountains, Thornthwaite method.

Profiles have been developed showing the variation with elevation of runoff, evapotranspiration, inter-ception, and precipitation. Rain gage data are so exploit, and precipitation. Rain gage data are so scattered that a smooth profile cannot be drawn with confidence. The correlation of runoff with elevation is 0.85 and the correlation of precipitation with altitude is 0.69. Scatter in precipitation data is caused by the nearly complete dependence of precipitation gage catch on local exposure factors. To estimate the relation of precipitation to altitude, a water budget method is used. Streams titude, a water budget method is used. Streams were gaged at bedrock control points to minimize subsurface runoff. Evaporation and evapotranspiration were estimated by the Thornthwaite method. Interception was estimated by empirical methods using field observation and study of topographic maps. Runoff intensity increased linearly with altitude, but total precipitation reached a maximum at about 5,000 ft altitude. The crest of the mountain range is over 8,000 ft high. (Knapp-USGS) USGS) W68-00944

TEMPERATURE AND CURRENT OBSERVA-TIONS IN CRATER LAKE, OREGON, Oregon State Univ., Corvallis. Dept. of Fisheries

For primary bibliographic entry see Field 02H. For abstract, see . W68-00954

THE RIVERS OF THE NAMIB AND THEIR DISCHARGE INTO THE ATLANTIC. PART II: OMARURU AND UGAB,

Namib Desert Research Station, South West

Africa H. W. Stengel

Sci Papers of the Namib Desert Res Station, No 30, Dec 1966. 35 p, 18 figs, 3 plates.

Descriptors: *Rivers, Runoff, *Watersheds (Basins), *Rainfall-runoff relationships, Groundwater, Dissolved solids, Water quality, Flow rates, *Hydrologic data, River beds, Rainfall disposition, Floods, Intermittent streams, Wet seasons, Atlantic Ocean, *Discharge (Water), Deltas, Cross-sec-

Identifiers: *Namib Desert, South West Africa, Omaruru Rivers, Ugab River, *River mouth.

The Omaruru and Ugab rivers, belonging to the central runoff area of southwestern Africa have been poorly documented unlike the Swakop and Kuiseb rivers of the same area. Further information was sought regarding these rivers. Rainfall in the catchment area, flow of the river to the Atlantic, descriptions of the mouth of the rivers and quality of the groundwater were discussed. The TDS (total dissolved solids) content of the Omaruru averaged aissolved solids) content of the Omaruru averaged + 500 ppm. The TDS content of the Ugab rose sharply from Sorris-Sorris to Brackputs and then steadily declined up to the coast. Nearly all the samples of the Ugab had an average TDS of 1800 ppm. The remainder were affected by the Brandberg West Mine, the only water consumer of the lower course. (Affleck-Ariz) W68-01001

2B. Precipitation

RAINFALL INTENSITY COMPARISONS FROM ADJACENT 6-HOUR AND 24-HOUR RECORDING RAIN GAGES,

Soil and Water Conservation Research Division, Southwest Watershed Research Station, Tucson, Arizona.

K. G. Renard, and H. B. Osborn. Water Resources Research, Vol 2, No 1, pp 145-146, Jan 1966. 2 p, 1 fig.

Descriptors: *Rain gages, *Rainfall intensity, Rainfall disposition, Thunderstorms, Meteorological data.

Identifiers: Walnut Gulch Experimental Watershed, Tombstone, Arizona.

Four widely separated sites were selected on the Walnut Gulch Experimental Watershed in southeastern Arizona for installation of adjacent 6hour and 24-hour recording rain gages, so that comparisons might be made of the precipitation intensities as derived from the records from the two types of gages. The maximum 2-, 5-, 10-, and 15minute intensities for all thunderstorms exceeding 0.25-inch total rainfall were compared. The shortduration intensity values derived from the 6-hour records were higher and more nearly correct as op-posed to the 24-hour records. The average 2-, 5-, 10-, and 15-minute intensities from the 24-hour gages were 13, 6, 5.5 and 2% low, as compared with corresponding intensities from the 6-hour gages. (Blecker-Ariz) W 68-00694

RAINFALL AND FLOODS DURING 1966 SOUTHWEST MONSOON PERIOD. India Meteorological Department, Headquarters Office, Hydrology Section, New Delhi.

Indian J of Meteorol and Geophys, Vol 18, No 3, pp 329-334, July 1967. 6 p, 2 fig, 6 chart.

Descriptors: *Rainfall disposition, *Meteorological data, *Monsoons, *Floods, Rivers, *Droughts, Precipitation excess, Moisture deficit, Isohyets, Fronts, Catchment basins, Storms. Identifiers: India.

The monsoon rainfall has been characteristic drought conditions over most of the northern pa of India. The worst affected areas were Bihar a east Uttar Pradesh. Some parts of Bihar received for the property of the parts of Bihar received for the parts of t east Ottar Pracesh. Some parts of Binar received floods. Although 6 depressions from the Bay Bengal crossed inland during the period, only to f them penetrated deep into the country but the did not improve the overall rainfall situation. D ing the first week of July and the last week of gust when break monsoon conditions prevail heavy rains occurred in the upper catchments neavy rains occurred in the upper catchments the rivers in Bihar, which sent their lower basins flood, ironically enough when other parts of State were experiencing drought condition (Blecker-Ariz) W68-00714

WHY IT DIDN'T RAIN IN 1967, Australia. Bureau of Meteorology, Victoria. A. K. Hannay. J of Agr (√ictoria), Vol 66, Part 1, pp 6-7, . 1968. 2 p, 3 maps.

Descriptors: *Air circulation, *Anticyclor *Rainfall disposition, Probability, Synoptic and sis, Atmospheric pressure, Isohyets, Fronts (mospheric), Convection, Air masses, Metec water, Droughts. Identifiers: Australia.

Between January and June of 1967, there was almost complete reversal of the pastoral situat that existed in Australia for the same period 1966. The reversal was related to the circulati in the various levels of the atmosphere. The us west to east progression of atmospheric eddies the south was effectively stopped or stalled for leveled to the south was effectively stopped or stalled for leveled to the south was effectively stopped or stalled for leveled to the south was effectively stopped or stalled for leveled to the south was effectively stopped or stalled for leveled to the south was effectively stopped or stalled for leveled to the south was effectively stopped or stalled for leveled to the south was effectively stopped or stalled for leveled to the south was effectively stopped or stalled for leveled to the south was effectively stopped or stalled for leveled to the south was effectively stopped or stalled for leveled to the south was effectively stopped or stalled for leveled to the south was effectively stopped or stalled for leveled to the south was effectively stopped or stalled for leveled to the south was effectively stopped or stalled for leveled to the south was effectively stopped or stalled for leveled to the south was effectively stopped or stalled for leveled to the south was effectively stopped or stalled for leveled to the south was effectively stopped or stalled for leveled to the south was effectively stopped or stalled for leveled to the south was effectively stopped or stalled for leveled to the south was effectively stopped or stalled for leveled to the south was effectively stopped or stalled for leveled to the south was effectively stopped or stalled for leveled to the south was effectively stopped or stalled to the south was effectively stopped or periods. The blocking pattern had been shown frequent slow-moving anti-cyclones in the sou east, centered much farther south than usual. R did not occur since one of the components of ra sustained upward motion in the atmosphere absent. The use of the probability approach, p the theory of persistence of synoptic types, dicated that there should be a return to nor rainfall behavior at Melbourne in Autumn, 19 (Blecker-Ariz) W68-00717

RAINFALL INTENSITY AND ELEVATION SOUTHWESTERN IDAHO,

U. S. Dept. of Agriculture, Agr. Research Servi Soil and Water Conserv. Div., Northwest Hyd Res. Center, Boise, Idaho; Michigan Univ., A

Arbor.
Charles F. Cooper.
Water Resources Res, Vol 3, No 1, pp 131-1
1967. 7 p, 4 fig, 2 tab.

Descriptors: *Rainfall intensity, *Elevation, *R gages, *Storms, Precipitation (Atmospheri *Hysometric analysis, Seasonal, Idaho, Convition, Orography, Probable maximum precipitati Cloudbursts, Meteorological data, Frequency arysis, Rainfall disposition.

The 93-sq-mile Reynolds Creek watershed in Owyhee Mountains of southwestern Idaho has approximately 1 recording rain gage per sq n operating since 1960. Average precipitation ran from 8 inches in the lower part of the Reyno Valley to 28 inches at highest elevation. Total nual precipitation increases about 4 in for e 1000-foot increase in elevation. High intensity ra fall results chiefly from spring and summer stor with a strong convective component. There is apparent relationship between elevation and p intensity or between elevation and total amo Intensity or between elevation and total amo falling at any given intensity. Since high inten rainfall is strongly localized, there is high probal ty that it will not be sampled by a single randon placed gage. The study reinforced previous ob-vations that rain gage densities of 1 or 2 per 100 miles are not adequate to determine probability infrequent high intensity rains within reasona time. Apparent lack of relationship between ra

Evaporation and Transpiration—Group 2D

fall intensity and elevation suggests that data from accessible valley stations can be used to estimate relative occurrence of high intensity rains throughout an area of appreciable range in elevation. (Blecker-Ariz) W68-00724

FEASIBILITY STUDY OF QUANTITATIVE RADAR MEASUREMENT OF PRECIPITATION ON LAKE MICHIGAN,

Illinois Univ. Urbana. Stanley A. Changnon, Jr., and Floyd A. Huff. Univ Illinois Water Resour Center, Final Rep, June

1966, 18 p, 3 fig, 3 tab, 16 ref.

Descriptors: Water yield, Hydrologic budget, Lake Michigan, Computer models, Meteorology, Ch-matology, Lake basins, Analytical techniques, Radar, Approximation method, Climatic data, Precipitation (Atmospheric).

This report describes research and findings of a 1yr project primarily directed toward use of radar to obtain accurate estimates of presently unmeasured precipitation over Lake Michigan. Detailed climatological analysis was performed to obtain generalized estimates of mean annual and seasonal precipitation to determine reasonable explanations for mean precipitation patterns derived. Results served to evaluate need for a future radar-instrumented project. One of 2 radar techniques studied showed promise for accurately measuring lake precipitation on a seasonal basis. This is based on an interpolation of radar-indicated precipitation using raingage data from both sides of the lake to calibrate the radar. Data from 19 rain periods on 2 dense raingage networks were used to evaluate the 2 radar techniques. Climatological analysis of lake precipitation was based on widespread and longterm land data, island station data, and new information from recent research on how the lake affects the precipitation processes. W68-01011

EFFICIENT DESIGN AND UTILIZATION OF RAINFALL NETWORKS, Georgia Institute of Technology, Atlanta. W. M. Snyder, and B. M. Courtney. Final Rep, Sch Civ Eng, Georgia Inst Technol, June 1967. 103 p. 36 fig, 19 tab, 9 ref, 2 append.

gages, Optimum use, Stream gages, Rainfall intensity. Descriptors: *Rainfall, Statistical analysis, Rain

Identifiers: Eigenvalues.

Monthly rainfall data were analyzed by methods of multivariate statistics. The analysis was designed to separate complex patterns of rainfall variability in winter and in summer into simpler independent patterns. Independent components of rainfall pat-tern were studied in an attempt to detect relationships with network size and configuration, with orientation of the gages to landsurface slope, and with gage elevation. The study was only nominally successful. It has been clearly demonstrated that multivariate statistics provide a powerful and effi-cient tool in rainfall data analysis. It has also been clearly demonstrated that rainfall patterns can be broken up into simpler, independent patterns. However, the definition of relationships between rainfall and network physical characteristics could not be brought to useful form. However, sufficient data from networks large enough for such deter-minations were not available. W68-01016

2D. Evaporation and Transpiration

THE DRYING OF SOIL: THERMAL REGIMES AND AMBIENT PRESSURES, U. S. Department of Agriculture, Agr. Research Service, Snake River Conserv. Center, Kimberly, Udber Liverstin Conserv.

Idaho; University of California, Davis.

J. W. Cary.

Agr Meteorol, Vol 4, No 5, pp 353-365, Sept 1967. 13 p, 3 fig, 3 tab, 18 ref.

Descriptors: *Evaporation control, *Drying, *Soil moisture, Water vapor, *Soil temperature, *Airearth interfaces, Water loss, Arid lands, Fluctuation, Soil profiles, Diurnal, Heating, Cooling, Heat flow, Vapor pressure, Diffusion, Mulching, Thermal properties, Atmospheric pressure, Geothermal studies, Osmotic pressure. Identifiers: *Ambient pressure.

Importance of evaporation from soil can hardly be over-emphasized when one considers the vast arid regions on earth. An insulated lucite cylinder 18 cm in diameter and 75 cm deep was used to hold a Columbia loam soil sample. 9 experimental treatments using continuous heating, continuous cooling, alternating temperature patterns, and various ambient pressures in all combinations were tested. The theory of water vapor contributing to evaporation is examined using equations. Thermal gradients will produce significant fluxes of water vapor in a moist soil profile which is subjected to natural diurnal temperature changes. Water loss from soils is dependent on these thermal gradients and soil temperatures. Transfer of water vapor up-ward through the dry layer to the soil surface is not strictly a molecular diffusion process. Loss of soil moisture may be reduced by reducing the transfer coefficient of water vapor between the moist soil and the atmosphere. Another way is to insulate soil from the energy supply of the atmosphere. The dry-ing of soil is basically a heat-flow problem with some parameters affecting heat-flow controlled by the simultaneous transport of soil moisture. (Blecker-Ariz) W68-00700

FAO/UNESCO/WMO AGROCLIMATOLOGY SURVEY OF A SEMI-ARID AREA SOUTH OF THE SAHARA,

Food and Agriculture Organization of the United Nations-Rome.

Jacques Cocheme.

Nature and Resources, Vol 2, No 4, pp 1-10, Dec 1966. 10 p.

Descriptors: Moisture availability, *Semiarid climates, Variability, Effective precipitation, Evapotranspiration, Rainfall intensity, Field crops, *Hydrologic budget, Evaporation, Crop response, Photoperiodism, Rainfall disposition, Radiation, Agriculture, Climatic data, Climatic zones, Ecotypes, Temperature.

Identifiers: *Agroclimatology, *Climatic resources,

Semiarid lands.

This survey inventoried climatic resources of a semi-arid tropical area in Africa south of the Sahara. Due to climatic zonation, native vegetation and soils were arranged zonally. Annual rainfall followed normal distributions. There was little variation in overall mean amount of rain per rainy day about 14 mm. Intensity duration studies showed rates as high as 100 mm were obtainable for short periods of time. Monthly mean potential evapotranspiration was calculated according to Penman's formula, and was found to be distributed zonally. Variability calculations over a 10 yr period showed annual potential evapotranspiration to be 4 times less variable than rainfall. Annual water budget, based on monthly mean amounts, was stu-died with agroclimatic interest in water deficit, water surplus, runoff, evaporation loss and effec-tive rainfall. 4 periods of availability of water were based on histograms of monthly mean rainfall and potential evapotranspiration. This survey included parts of the following countries: Senegal, Mauritania, Mali, Upper Volta, Ghana, Togo, Dahomey, Niger, Nigeria, Cameroon and Chad. (Blecker-Ariz) W68-00702. W68-00702

NEW METHODS FOR DETERMINING LAKE EVAPORATION LOSS,

Illinois State Water Survey, Urbana, Illinois. John B. Stall, and Wyndham J. Roberts.

J Amer Water Works Assoc, Vol 59, No 10, Part 1, pp 1249-1256, Oct 1967. 8 p, 5 fig.

Descriptors: *Evaporation, *Lakes, *Evaporation pans, *Wind velocity, *Methodology, Hydrologic cycle, *Energy budget, *Air temperatore, Airwater interfaces, Dew point, Winds, Solar radiation, Data collections, Water supply, Reservoir storage, Water loss, Reservoir yield, Variability.

Quantitatively evaporation accounts for a major portion of the water involved in the hydrological cycle. Water supply systems that utilize impounding reservoirs suffer considerable loss from evaporation at the lake surface. The evaporation of water from a free surface is discussed. The use of the Class A evaporation pan for the direct measurement of evaporation is discussed along with its draw backs. A methodology for the computation of both pan and lake evaporation, was developed by research scientists of the Environmental Services Administration - Weather Bureau. An energy budget for water evaporation from a pan and a lake were determined. The four key factors in climate that were responsible for pan and lake evaporation were air temperature, dew point temperature, wind movement and solar radiation. (Blecker-Ariz) W68-00709

EVAPORATION FROM VEGETATED AND FALLOW SOILS,

U. S. Geological Survey, Buckeye, Arizona. T. E. A. Van Hylckama. Water Resources Res, Vol 2, No 1, pp 99-103, 1966. 5 p, 3 fig, 2 tab.

Descriptors: *Water loss, *Fourier analysis, *Evaporation, Recharge, *Vegetation effects, Water table, Evapotranspiration, *Lysimeters, Soil moisture, Tamarisk, Diurnal.

In 1962 five evapotranspirometers were located southeast of Buckeye, Ariz. Two were planted in salt cedar and the others were left bare. The goal was to determine the water losses from bare soil compared with losses from vegetated soil exposed to virtually identical natural surroundings. Harmonic analysis provided a method of describing periodic phenomena. The double peak of the second harmonics was present. The first peak (in the morning) was due to actual evaporation, the second (in the evening) was due to recharge. The near disappearance of the second harmonic in the middle of July was explained by assuming that the vegetation covered the soil. The reappearance of the second harmonic in August and September was possibly due, not to evaporation, but to recharge of the soil above the water table. (Blecker-Ariz) W68-00716

STATUS OF EVAPORATION MEASUREMENTS IN THE UNITED STATES,

U S Geological Survey. G. Earl Harbeck, Jr. Int Ass of Sci Hydrol, Publ No 78, pp 285-291, Bern, Switz, 1967. 7 p, 19 ref.

Descriptors: *Evaporation, *Reservoir evaporation, *Methodology, *Energy budget, Evaporation pans, Mass transfer, Reservoir design, Networks, Water loss, Climatic data.

Identifiers: Evaporation maps, Eddy-flux method, Lake Hefner study, Salton Sea study.

Techniques for the measurement of evaporation from reservoirs are described. The choice of technique is largely economic. The energy budget method gives accurate information at most reservoirs but it uses expensive equipment and much manpower. Estimates of evaporation from evapora-tion maps, which in turn are based on evaporimeter data, are adequate for most purposes. A mass-transfer technique is often suitable for small ponds or reservoirs but it is not successful when inflow and outflow are large in comparison with reservoir volume. The eddy-flux method involves measurement of vertical atmospheric turbulence and short

Group 2D—Evaporation and Transpiration

term fluctuation of properties such as heat, water vapor, or momentum. The theory is simple and rigorous, but instrumentation is as yet un-developed. The amount of data produced would be large enough to make computer solutions attractive. (Knapp-USGS)
W68-00956

RESEARCH ON EVAPORATION REDUCTION RELATING TO SMALL RESERVOIRS, 1963-65, Arizona Univ, Tucson, Institute of Water Utiliza-tion, Agr Exp Station.

For primary bibliographic entry see Field 03B. For abstract, see

W68-00999

STUDY OF WATER EVAPORATION FROM

SOILS, U.S.S.R. Institute of Physical Chemistry. B. V. Deryagin, N. N. Zakhavayeva, and A. M. Lopatina.

Soviet Soil Sci, Vol 2, pp 147-150, Feb 1966. 4 p, 3 fig, 1 tab, 17 ref.

Descriptors: *Evaporation control, *Coatings, *Thin films, *Soil moisture, Capillary action, Retardants, Molecular structure, Water loss, Monomolecular films, Quartz, Sands, Porosity, Dispersion, Laboratory tests, Wetting, Alcohols, Reservoir evaporation, Air-earth interfaces, Surfactants, Saturation. Identifiers: *Thermostats, Aliphatic acid

Studies were made of water evaporation from quartz sand with varying degrees of dispersion. Film from a solution in a hexane of aliphatic acid or alcohol was applied to the surface of sand which had been wetted with water. The sample was put in thermostat and at a specific temperature and air moisture, water was evaporated from the soil. Evaporation of water from soil decreased whenever the soil surface was coated with films of aliphatic acids of different molecular weight. As length of the molecular chain decreased, evaporation rate decreased. Similar results were obtained with alcohol films. Coatings from a solution of myristic acid in a hexane produced more significant decrease in water evaporation than pure hexane. A film of aliphatic acid was effective. Water evaporation was decreased by two-thirds when hydrophobic coatings of polysiloxane liquids (ethylpolysiloxane, methylpolysiloxane, isobutylpolysiloxane) were applied to the soil surface. Soils to which coatings of surface-active and hydrophobizing substances (polysiloxane liquids) were applied, lost their capactiy to be saturated by the liquid after re-peated wetting (after drying). (Blecker-Ariz) W68-01006

2E. Streamflow and Runoff

FLOW DURATION OF OHIO STREAMS BASED ON GAGING-STATION RECORDS THROUGH

U. S. Geological Survey, Columbus, Ohio. William P. Cross.

Ohio Div Water Bull 42, 1968..68 p, 1 map, 2 tab.

Descriptors: *Streamflow, *Frequency analysis, *Discharge (Water), *Data collections, *Ohio, Flow characteristics, Peak discharge, Floods, Surface waters, Low flow, Streams, Running waters, Hydrologic data, Gaging stations, Stream gages,

Average flow.

Identifiers: *Low-flow frequency, *Flow duration,
Annual flow, High flow, Mean flow, Flow frequency,
Periodic observations.

Flow-duration tables are presented for 164 gaging stations in Ohio for the 10-yr period ending Sept 30, 1965. Only 60 of the gages are on streams unaffected by storage structures. A map shows locations of all gaging stations for which flow-duration tables are included. The 5-yr records are included, but records less than 3 yr in length are omitted and appear in another listed report. The location of each gage is described; the drainage area for each gaged stream, the period of record, the computed maximum, minimum, and mean discharges, and remarks are given for each station. (Knapp-USGS) W68-00670

A TECHNIQUE FOR THE EVALUATION OF DROUGHT FROM RAINFALL DATA, Republic of South Africa, Department of Water Affairs, Division of Hydrological Research, Pre-

P. H. Herbst, D. B. Bredenkamp, and H. M. G.

J of Hydrology - Amsterdam, Vol 4, No 3, pp 264-272, Oct 1966. 9 p, 2 fig.

Descriptors: *Time, *Droughts, *Analytical techniques, Computers, Rainfall disposition, *Analytical Precipitation intensity, Duration curves, Data collections, Meterological data, Depth-area-duration analysis, Annual, Seasonal, Variability, Monthly, Moisture deficit.

Identifiers: Drought severity, Drought index.

Tests are given to determine the duration and intensity of droughts, the onset of drought and the termination of droughts. Included are the preconditions that monthly rainfall must follow in order to be used in these tests. An index of drought severity was developed to compare droughts of varying duration and intensity in regions of high or low rainfall irrespective of the seasonal variation in precipitation. The tests are programmed for a computer in order to facilitate the investigation of data from a large number of rainfall stations. (Blecker-W 68-00741

HYDRAULIC GEOMETRY OF **ILLINOIS** STREAMS,

Ill State Water Survey, Urbana, Ill. John B. Stall, and Yu-Si Fok. III Univ Water Resources Center, Res Rep No 15, July 1968. 47 p, 26 fig, 10 tab, 39 ref.

Descriptors: *Channel morphology, *Discharge coefficients, *Flow characteristics, *Hydraulic properties, *Hydrodynamics, Illinois, Open channel flow, Drainage density, Roughness (Hydraulic), Shape, Slopes, Width, Geomorphology, Velocity, Equations.

Identifiers: Hortons law, Strahler net, Hydraulic geometry, Stream order, Rating curves.

A consistent pattern was evaluated in which the width, depth, and velocity of flow in a stream vary along the course of the stream at a constant discharge of given frequency. These channel characteristics are termed hydraulic geometry and constitute an interdependent system which is described by a series of graphs of simple form, or by simple power equations. The data from 166 stream gaging stations in Illinois are assembled and used to develop the hydraulic geometry parameters of these streams. Results are presented as separate sets of equations for 18 river basins in Illinois. Stream characteristics are related to frequency of discharge and to drainage area as independent variables. Stream velocities computed from hydraulic geometry equations check favorably with actual stream velocities. These equations are used to predict the average depth and velocity of flow at problem locations on the stream where no measurements are available, allowing computation of the reoxygenation capacity of the stream, which is valuable for many purposes in water resources development. (Knapp-USGS) W68-00806

HYDROLOGY OF A DRAINAGE BASIN ON THE ALASKAN COASTAL PLAIN, Army Materiel Command.

J. Brown, S. L. Dingman, and R. I. Lewellen Cold Regions Res and Eng Lab Res Rept 240, 18 p, April 1968. 6 fig, 9 tab, 26 ref. Descriptors: *Drainage systems, *Runofl *Watersheds (Basins), Alaska, Precipitation, Per mafrost, Evapotranspiration.
Identifiers: *Alaskan Coastal Plain, Stream chemis

A 4-summer hydrologic record from a 1.6-sq km drainage basin at Barrow, Alaska, is analyzed. Ru noff varied greatly from storm to storm, occurrin primarily through and over the tundra mat and polygonal trough-pond system. Analyses of hydro graphs revealed: (a) lag times generally from 3 to 10 hr; (b) 50 hr and occasionally 160-hr recession constants; and (c) runoff from individual storm between 1 and 70%. The 43-yr means of summe climate are: thaw period, 88 days; precipitation, 5 mm. About 5% of the thaw season precipitation normally runs off. Pan evaporation for an averag thaw season is about 160 mm and evapotranspira tion, which is essentially in balance with precipita tion, is about 60 mm. Precipitation chemistr showed no correlation with storm direction. As suming all winter precipitation runs off, and the data spatially and temporally representative, about 50% of the measured annual precipitation in thir region runs off into the Arctic Ocean. (Llaverias USGS) W68-00830

FUNDAMENTAL FLOWS IN POROUS MEDIA, State Rivers and Water Supply Comm, Victoria

For primary bibliographic entry see Field 08B For abstract, see. W68-00833

THE VARIATION OF DRAINAGE DENSITY WITHIN A CATCHMENT,

Exeter Univ., Exeter, England.
K. J. Gregory, and D. E. Walling.
Bull Int Ass Sci Hydrol, Vol 13, No 2, pp 61-68
June 1968. 8 pp, 2 fig, 24 ref.

Descriptors: *Drainage density, *Streamflow *Streamflow forecasting, *Mathematical models Drainage patterns (Geologic), Tributaries Discharge (Water), Hydrology, Non-perennia streams, Synthetic hydrology, Intermittent streams Flow characteristics. Identifiers: *Hortons law, Catchment area, Stream length, Peak flow.

Discharge from 2 experimental catchments are re lated to the length of channel flow. Length of chan nels is equivalent to drainage density for an catchment; density, in the experimenta catchments, is related to discharge by a function approximately of the form Q (discharge) varies a D (density) squared. The drainage density, how ever, is not constant within a drainage basi because the total length of flowing stream channel (or the number of intermittent segments actuall flowing) varies with the total system discharge. In many cases it has been observed that peak and bas flow have different relationships to density whe density is treated as constant. When density is re garded as a variable and the appropriate density i determined for each discharge, it is found that the are related by the relation Q varies as a power of I for all Q, whereas when D is regarded as constant only peak or long-term average Q is related to D. The relationship of Q to variable D is valid even in the many streams which have very high peak flow and very small base flows, because such stream have many intermittent and ephemeral tributarie and therefore have more flow-length (or drainag density) variation than other more uniformly flowing streams. (Knapp-USGS)
W68-00835

OPTIMUM GAGING STATION LOCATION, U S Geological Survey, Washington, D. C. For primary bibliographic entry see Field 07A. For abstract, see. W68-00879

Streamflow and Runoff—Group 2E

AN EXTENSION TO THE THOMAS-FIERING MODEL FOR THE SEQUENTIAL GENERA-TION OF STREAMFLOW,

Washington Univ., Seattle. Archie A. Harms, and Thomas H. Campbell. Water Resources Research, Vol 3, No 3, pp 653-661, Third Quarter 1967, 9 p, 12 fig, 5 ref.

Descriptors: *Synthetic hydrology, *Runoff, *Sequential generation, Streamflow, Markov processes, Statistical models. dentifiers: Autocorrelation, Monthly runoff.

An extension to an algorithm for the sequential generation of nonhistoric streamflow, previously used by Thomas and Fiering, is suggested. The distinguishing features of this model are preservation of (1) normal distribution of annual flows; (2) log-normal distribution of monthly flows; (3) correlation between annual flows; and (4) correlation between monthly flows. This model has been applied to two representative Pacific Northwest rivers. A graphical examination of the results sug-gests that this model provides an authentic representation of streamflow. (Authors) W68-00911

LA DIMINUTION DE L'ECOULEMENT RIVERAIN EN POLOGNE AU COURS DU SIE-CLE PRESENT. (DIMINUTION OF RIVER DISCHARGES IN POLAND IN THE TWENTIETH CENTURY) (FRENCH), National Meteorological and Hydrological Inst., Juliusz Stachy

Juliusz Stachy.

Geophysics, Rainfall.

Bull of Int. Ass. of Sci. Hydrology, Vol 13, No 1, pp 20-24, Feb 1968. 5 p, 2 fig, 1 tab, 8 ref.

Descriptors: *Streamflow, Theoretical analysis, *Discharge measurement, Rainfall-runoff relationships, *Low flow, Regression analysis, Fresh water, River flow, Precipitation (Atmospheric). Identifiers: *Poland, Global hydrology theory,

Average stream discharge values in Poland over a long period of time were compared with present streamflow measurements. The measurements were made at the mouth of the Vistula from 1901-1960 and show decreasing values for average discharge. To determine whether the phenomenon of decreased flow was specific to Poland, a hydrological study was made of the Elbe and Neman Rivers, on the west and east, respectively, of Poland. Regression analysis based on the 1901-1960 period was used to calculate average annual values of flow decrease; absolute and relative values of flow decrease; absolute and relative values were also considered. Regression coeffi-cients of average discharge are tabulated for the Oder, Rega, and Vistula Rivers. An hypothesis is examined as to whether lower flow rates are due to less precipitation, and previous studies suggesting that smaller flow was due to less precipitation are briefly reviewed. It is stated that the hypothesis cannot be adequately substantiated since the basic data used were probably somewhat inexact, and the period studied, too short. (Llaverias-USGS) W68-00926

ON THE SOLUTION OF THE MUSKINGUM FLOOD ROUTING EQUATION, Israel Institute of Technology, Haifa, Israel,

Hydraulic Lab.

M. H. Diskin. J Hydrol, Vol 5, No 3, pp 286-289, Sept 1967. 4 p,

Descriptors: *Flood routing, *Water storage, *Mathematical studies, Channels, Flood forecasting, Floods, Hydrographs.
Identifiers: *Muskingum method.

The Muskingum flood routing equation is solved by use of Laplace transforms. The product of such transforms is inversely transformed into a convolutional integral. The result obtained is identical to Kulandaiswamy's earlier solution which was given

without proof. Other previous solutions were restricted to special cases. (Knapp-USGS) W68-00948

FLOOD ROUTING THROUGH CHANNELS,

Guindy, Madras, India, College of Engineering. V. C. Kulandaiswamy, M. Krishnaswami, and T. N Ramalingam.

J Hydrol, Vol 5, No 3, pp 279-285, Sept 1967. 7 p, 3 fig, 1 tab, 5 ref.

Descriptors: *Flood routing, *Hydrographs, *Water storage, Channels, Mathematical studies, *Hydrographs, Flood forecasting, Floods, Digital computers, Least squares method. Identifiers: *Muskingum method.

A new hydrologic flood routing equation is proposed which makes use of a general storage equation taking into account the unsteady effects of the flood wave by time derivatives of inflow and outflow. The equation is checked against a few flood hydrographs in channel reaches. All calculations were made by digital computer. The curves developed fit the cases better than curves fit by the Muskingum method. (Knapp-USGS) W68-00949

A REVIEW OF RADIOISOTOPE METHODS OF STREAM GAGING,

Australia Atomic Energy Comm, Lucas Heights, N S W, Australia. W. R. Ellis.

J Hydrol, Vol 5, No 3, pp 233-257, Sept 1967. 25 p,

Descriptors: *Stream gages, *Discharge measurement, *Tracers, *Radioactivity techniques, *Radioisotopes, Equipment, Current meters, Instrumentation, Flowmeters, Gaging stations, Hydrographs, Streamflow, Dye releases, Heavy water, Tritium, Gold radioisotopes. Identifiers: *Australia, Stream gaging, Bromine addioisotopes. Compared to the control of t

radioisotopes, Copper radioisotopes.

Methods of gaging streamflow are reviewed with particular emphasis on radioisotope tracer methods. Conventional flowmeter and weir methods are discussed. In many areas, particulary arid regions, inaccessibility and extreme variability of flow make conventional methods impractical or make frequent recalibration of gages necessary. Radioactive tracer methods, including activationanalysis chemical tracer methods, measure discharge directly and need calibration only once. They may be used as primary gaging methods or to calibrate conventional gages. The isotope dilution method uses a tracer added to the stream at a constant rate. The discharge of the stream may be calculated from tracer concentration at the point of complete mixing. In the total count method a quantity of tracer is added rapidly to the stream. The total number of counts received is directly proportional to the total energy of the tracer added and inversely proportional to discharge. In the continuous sample method, a measured quantity of tracer is added rapidly, and samples are taken during passage of the tracer. The mixed sample is counted to find average concentration, which is related to discharge in the same way as total count. Choice of tracer, calibration, equipment, sensitivity, safety, and costs are discussed. (Knapp-USGS) W68-00953

THE DESIGN OF PROPORTIONAL AND LOGARITHMIC THIN-PLATE WEIRS, Bristol Univ., Dept. of Civil Engineering. For primary bibliographic entry see Field 07B. For abstract, see . W68-00960

METHODS FOR PREDICTING DISPERSION NATURAL WITH APPLICATIONS TO LOWER REACHES

OF THE GREEN AND DUWAMISH RIVERS, WASHINGTON.

U S Geological Survey.

Hugo B. Fischer. U S Geol Surv Prof Pap 582-A, pp A1-A27, 1968. 27 p, 27 fig, 1 tab, 17 ref.

Descriptors: *Dispersion, *Surface water, *Natural stream, Normal flow, Dispersion coefficient, Washington. Identifiers: *Green and Duwamish Rivers, Elec-

tronic computer method, Logarithmic velocity

In a contribution to a more complete understanding of the dispersion mechanism in a natural stream, and to provide a method for more accurately predicting dispersion coefficients, four dye dispersion experiments were conducted in the Green and Duwamish Rivers, Washington. Dispersion was observed during normal riverflow and tidal reversals. In normal flow of about 300 cfs the observed dispersion coefficient was 70 to 90 sq ft/sec. The hypothesis of lateral variation in velocity in natural riverflow was used in conjunction with Taylor's theory for turbulent dispersion in pipes; the resultant analysis predicts a dispersion coefficient of 88 sq ft/sec for a 300 cfs/flow. The electronic computer was used in obtaining a numerical solution to the convective diffusion equation. Analysis of a two-dimensional flow with logarithmic velocity profile shows that the program produces accurate results. The numerical and analytical analyses provide two methods of predicting a dispersion coefficient for a natural stream. This prediction requires field measurement of channel geometry, shear stress, and cross-sectional distribution of velocity only. (Llaverias-USGS) W68-00962

TWO WEIRS FOR ACCURATE STREAM-GAG-ING OF SMALL WATERSHEDS, Pennsylvania State Univ, University Park.

For primary bibliographic entry see Field 07B. For abstract, see W68-00970

THE PROFILE OF A RANDOM STREAM, Northwestern Univ, Evanston.

Michael F. Dacey. Water Resources Res, Vol 4, No 3, pp 651-654, June 1968. 4 p, 6 ref.

Descriptors: *Stochastic processes, Mathematical studies, Drainage, Probability, Statistical models, Synthetic hydrology, Watersheds (Basins), Flow profiles, Geomorphology. Identifiers: *Drainage basin characteristics, Stream

A probabilistic formulation is given for the profile of a stream. The elevation of a stream is considered of a steam. The best of the stream of the stream of the stream of the model are (1) between the jth and (j+1)th points stream elevation remains constant or drops by a unit of elevation, and (2) the probability p of decrease between the jth and (j+1)th points is independent of j. Two formulations of the model are examined by assuming that p is constant throughout the stream length, and that p is a ranthroughout the stream length, and that p is a random variable. The model is analyzed for these two cases, and results include the frequency functions, means, and variance of length of stream from its origin to 'sea-level' and for elevation of stream at each point j. (Knapp-USGS) W68-00974

HORTON'S LAW OF STREAM NUMBERS, U S Geological Survey, Urbana, Ill. A. E. Scheidegger. Water Resources Res, Vol 4, No 3, pp 655-658, June 1968. 4 p, 10 ref.

*Geomorphology, *Stochastic Descriptors: *Geomorphology, *Stochastic processes, Tributaries, Mathematical studies,

Field 02—WATER CYCLE

Group 2E—Streamflow and Runoff

Rivers, Probability, Statistical methods, Streams, Synthetic hydrology. Identifiers: *Horton's law, Stream order, Statistical

graph theory, Bifurcation ratio.

The possibilities for obtaining a rational explana-tion of Horton's law of stream numbers are reviewed. The previous explanations of the streamreviewed. The previous explanations of the stream-number law by (1) a growth model referring to generations of rivers and by (2) statistical graph-theory are compared. The graph-theoretical ex-planation seems superior to the other model of Horton's law, inasmuch as it produces not only the form of the law, but even, numerically, the naturally observed bifurcation ratio. Also, it is independent of the structural properties of the river net. (Knapp-USGS) W68-00975

WHAT HAPPENS TO FLOOD RUNOFF,

Arizona Univ, Tucson. W. G. Matlock.

Progressive Agr in Arizona, Vol 18, No 2, pp 8-10, March-April 1966. 3 p, 4 fig.

Descriptors: Floods, Runoff, Arid climates, Groundwater recharge, Flumes, Velocity, Bottom sediments, Sediment load, Natural recharge, Infil-

To help answer some of the questions about runoff water from the desert and consequent natural recharge, a laboratory flume study was made to determine the relationships of flow velocity, suspended sediment content and infiltration rates. A closely controlled environment for the investigation of these relationships was resided by 100.00 tion of those relationships was provided by a 100-ft tilting bed flume. Infiltration rates varied directly with flow velocity in the range from 2 to 5 ft per second as a consequence of bed sediment movement and particle rearrangement. Adding a suspended sediment load to clear water resulted in an immediate and dramatic reduction in infiltration rate at all velocities tested. Observations revealed some subsurface layering of fine materials and the formation of a compact layer at the bed surface. A sediment load could not be carried by the flow without charging help compacting and advanced to the control of the without changing bed composition and reducing in-filtration rates. (Blecker-Ariz) W68-01007

2F. Groundwater

TERTIARY AQUIFERS IN THE MISSISSIPPI EMBAYMENT, WITH DISCUSSIONS OF QUALITY OF THE WATER, BY H. G. JEF-

U. S. Geological Survey.
R. L. Hosman, A. T. Long, and T. W. Lambert.
U. S. Geol Surv Prof Pap 448-D, pp D1-D29, 1968.
29 p. 4 fig, 8 plate, 14 tab, 63 ref.

Descriptors: *Aquifer characteristics, *Geohydrologic units, *Water quality, *Geologic control, Appraisals, Hydraulics, Stratigraphy, Hydrogeology, Tertiary Period, Aquifers, Aquicludes, Transmissivity, Groundwater move-

Aquictudes, Iransmissivity, Groundwater movement, Water supply. Identifiers: *Aquifer systems, *Hydrologic framework, *Mississippi embayment, Potential water supply, Vertical leakage.

Aquifers of the Tertiary System, Mississippi embay Aquifers of the lertiary System, Mississippi embayment, are described as geohydrologic units, and unit summaries are given of recharge sources, groundwater movement, withdrawal, water quality, aquifer characteristics, and potential use. Tertiary sediments, surface and subsurface, occur in 75% of the embayment and have a maximum thickness of 7,000 ft. Water in the subject aquifer contains less than 1,000 ppm dissolved solids in a 75,000 sq mi region in which the aquifers furnish nearly all the water supplies. Total regional withdrawal is 500. water supplies. Total regional withdrawal is 500 mgd, mostly from the shallowest aquifer in the respective places of development. Usually 2 or more Tertiary aquifers are available and are areally extensive; some contain fresh water at depths of

2,000 ft and more. Hydraulic characteristics differ from aquifer to aquifer and within aquifers; permeabilities of the lower Wilcox sediments are generally higher, but a unit in the Claiborne Group (the Memphis aquifer-Sparta Sand) is the most productive. Summary tables are given of chemical analyses of water from 11 aquifer units, and 2 geologic sections and 6 geohydrologic maps are presented as plates, scale 1:2,000,000, in a separate vol. (Lang-USGS) W68-00657

DETERMINATION OF CONSTANT RATE DEEP RECHARGE OR DISCHARGE FROM GROUND-

WATER LEVEL DATA, Institute for Land and Water Management Research, Wageningen, the Netherlands. G. W. Bloemen.

Inst for Land and Water Manage Res, Wageningen, the Netherlands, Tech Bull 53, pp 58-68, 1968. 11 p, 8 fig, 2 tab, 6 ref.

Descriptors: *Groundwater, *Recharge, *Mathematical studies, Water levels, Potentiometric level, Flow, Groundwater movement, Pressure, Storage, Pressure head, Precipitation excess, Evapotrans-piration, Canal seepage, Rainfall disposition. Identifiers: *Graphical methods, Discharge-recharge calculations, Head-discharge relations, Netherlands, Seepage intensities, *Discharge.

Recharge or discharge may be calculated in an area with groundwater drains by a graphical method which uses water-level and rainfall surplus (precipitation minus evapotranspiration) data. The head of pressure over the drain level (tiles or ditches) is plotted against rainfall surplus. Change of storage is eliminated by plotting rainfall surplus against change in water level. From this the rainfall surplus value coinciding with zero change in level (or zero change in storage) is determined. This is used with results from the first plot to determine the head coinciding with the rainfall surplus that yields zero storage change. Then for each well, rainfall surplus minus storage change may be plotted against head. A simple calculation from these data yields the discharge intensity at the well. Integrating many such point values will give an areal discharge or recharge value, and dischargerecharge contour maps may be drawn. (Knapp-USGS) W68-00658

ANALYSIS OF TRANSIENT FLUID FLOW IN MULTI-LAYERED SYSTEMS, California Univ., Berkeley. Iraj Javandel, and Paul A. Witherspoon. Univ of Calif Water Resources Center Contrib No 124, 119 p, Mar 1968. 34 fig, 2 tab, 74 ref.

Descriptors: *Flow, *Water-bearing formations, Discharge (Water), Numerical analysis. Identifiers: Boundary value problem, *Multi-layered systems, Radial aquifer, Infinite element

An analytical solution was derived to give potential distribution in an infinite, two-layer aquifer with cross flow pumped by a well partially penetrating cross flow pumped by a well partially penetrating the fluid bearing formation, at a constant rate of discharge. A numerical computation method, known as the 'infinite element' method, which is based on the minimization of an appropriate variational principle using a direct method of the calculus of variations in conjunction with a discretized continum, was reviewed and extended. When compared for validity, nonsteady state results were found to be in excellent agreement with results of typical boundary value problems embodying analytical solutions. The finite element method was then used to investigate complex problems of transient fluid flow in layered systems. Cases of both complete and partial penetration in the pumping well were successively analyzed. It is concluded that the generality of this approach with respect to arbitrary boundary conditions and changes in rock properties provides a new method of handling fluid

flow problems in complex systems. (Llaveria W68-00660

GROUND-WATER LEVELS IN IDAHO 1968,

U. S. Geological Survey, Boise, Idaho. R. L. Whitehead, and H. G. Sisco. Idaho Dep Reclam Water Inform Bull No. 5, Ju 1968. 67 p, 31 map, 31 tab (unnumbered).

Descriptors: *Groundwater, *Idaho, *Water leve *Water-level fluctuations, Water wells, Data co lections, Observation wells, Depth. Identifiers: *Well data, *Water-level measur ments, *Periodic observations.

An observation-well network, designed to monit changes in groundwater levels in 420 wells d tributed throughout Idaho, is being maintained the U.S. Geological Survey in cooperation with t Idaho Department of Reclamation. Maps a presented showing the location of all netwo wells, the water levels measured in spring 196 water-level changes between spring 1967 a spring 1968, and hydrographs representative water-level trends. Water-level measurements f other periods of record are available from t USGS and the Idaho Department of Reclamation Boise, Idaho. (Knapp-USGS) W68-00671

AQUIFER WATER RESISTIVITY--SALINIT RELATIONS,

Sydney Univ., Department of Geology as Geophysics, Sydney, Australia. D. W. Emerson.

J and Proc, Royal Society of New South Wales, V 101, Part 1, pp 17-21, 1967. 5 p, 4 fig, 1 tab, 16 re

Descriptors: *Aquifers, *Salinity, *Resistivity, D solved solids, Groundwater, Ions, Water quality Water analysis, Hydrogeology.

The estimation accuracy of methods to determi reciprocal resistivity on published data of forty-fl New South Wales groundwaters were studied, the methods tested, the 100/T was the mo-satisfactory followed by the Dunlap and Hawthor and Logan-normal methods. The 6400/ppm a Jones and Buford average natural methods ga poorer results. Large errors may result in attempt to solve both the forward and inverse problems no information was available as to the nature of d solved solids in waters. (Blecker-Ariz) W68-00742

FACIES CHANGES IN SOUTHWESTERN CA MEL (ISRAEL) AND THEIR INFLUENCE O GROUNDWATER REGIME,

Geol Surv of Israel, Div of Hydrogeolog

U. Kafri. Israel J Earth Sci, Vol 16, No 4, pp 206-214, D 1967. 9 p, 7 fig, 2 tab, 16 ref.

Descriptors: *Groundwater, *Aquifer charateristics, *Water quality, *Groundwater barrie Confined water, Groundwater movement, Kar Reefs, Carbonate rocks, Aquicludes, Geohydrolc ic units, Aquifers, Water yield, Specific capacity. Identifiers: Israel, Reef facies, Facies change Synclines.

Study of samples from recent boreholes in the Ba Shelomo and Caesarea areas indicates a southwe ward extension of the synclinal Daliya Formatic ward extension of the synclinal Daliya Formatic This feature was also recognized on gravity residumaps. The synclinal structure is flanked by permeable reef zones. Wells drilled into the miginal reef zones have relatively high yields (25 870 cu m per hr), and specific capacities of 8 1,400 cu m per hr per m. Wells in the synchin Daliya Formation yield 15-60 cu m per hr with specific capacity of 0.17-2.12 cu m per hr per Salinity increases from 16.2 meq per 1 to 28.9 m per 1 from the edge to the center of the synchin The permeable marginal reef facies zones act as water conduits while the relatively impermeable central synclinal facies acts as a groundwater barrier. This system alters the regional E-W flow of groundwater to a SW flow in the reef area. (Knapp-USGS)

W68-00809

HYDROGEOLOGICAL INVESTIGATIONS IN THE WESTERN CATCHMENT OF THE DEAD SEA.

Geol Surv of Israel and Tahal Water Planning for

Israel Ltd.

A. Arad, and A. Michaeli. Israel J Earth Sci, Vol 16, No 4, pp 181-197, Dec 1967. 17 p, 10 fig, 2 tab, 11 ref.

Descriptors: *Groundwater, *Water wells, *Hydrologic budget, *Aquifers, *Hydrogeology, Infiltration, Recharge, Water balance, Water quality, Chemical analysis, Groundwater basins, Water sources, Water yield, Hydrologic properties, Specific capacity, Permeability, Transmissivity. Identifiers: *Israel, Dead Sea Basin, Hydrogeological survey.

The groundwater balance of the western Dead Sea Basin, which lies between the Judean Hills to the west and the Dead Sea to the east, is evaluated. Most of the area is mountainous with a relief of 1,000 to 1,400 m. The average rainfall varies from 50 mm per yr at the Dead Sea to 500 mm at the western edge of the area. Recharge ranges from 10 to 330 mm per yr. Estimated transmissivity is about 200 sq m per day. The main aquifers are the Lower Cretaceous sandstone, the upper Cenomanian dolomitic limestone, and the graben-fill aquifers. Surface runoff is negligible where formations are exposed and is only 10% of precipitation where infiltration is low. Estimated total recharge is 70-100 million cu m of which 90% takes place near the eastern edge of the area. Total pumpage far exceeds recharge; water is being mined from the Cretaceous Nubian Sandstone. Groundwater is of the bicarbonate type in the eastern recharge area, sulfate type in the central zone, and chloride type in the Judean Wilderness, Rift Valley, and Dead Sea Depression. (Knapp-USGS) W68-00810

GEOLOGY AND GROUND WATER RESOURCES OF GRAND FORKS COUNTY, NORTH DAKOTA PART II-GROUND WATER WATER BASIC DATA,

U. S. Geological Survey. T. E. Kelly.

N Dak Geol Surv Bull 53, 1968. 117 p, 2 fig, 1 plate, 4 tab, 10 ref.

Descriptors: *Groundwater, *Water wells, *Water quality, *Water levels, *Data collections, Hydrologic data, Aquifers, Drill holes, Logging Hydrologic data, Adulters, Drill holes, Egging (Recording), Chemical analysis, North Dakota, Hydrogeology, Water table, Springs, Water yield. Identifiers: *Drillers logs, *Periodic observations, Grand Forks, Well logs, Test holes, Water level measurements.

An investigation was made of the geology and groundwater resources of Grand Forks County, N. D., to determine the location and extent of aquifers, and to evaluate occurrence, movement, and chemical quality of the groundwater. Locations and descriptions of about 1,000 wells, springs, and test holes are given. Water-level measurements were made periodically in 69 observation wells. Logs of about 160 test holes and selected wells are included and 96 chemical analyses of water samples are presented. The water levels in the observation wells were measured periodically from the summer of 1964 until present; 4 wells have automatic water-level recorders. The chemical analyses generally include determinations of silica, iron, calcium. magnesium, sodium, potassium (or sodium and potassium together), alkalinity as carbonate and bicarbonate, sulfate, chloride, fluoride, nitrate, boron, dissolved solids, pH, and specific con-

ductance. The sources and significance of the various constituents and properties of natural waters are discussed. (Knapp-USGS) W68-00811

GROUND-WATER LEVELS IN THE UNITED STATES 1961-65. U.S. Geological Survey.

U S Geol Surv Water-Supply Pap 1845, 1968. 199 pp, 9 fig.

Descriptors: *Groundwater, *Water wells, *Hydrologic data, *Water levels, *Water level fluctuations, Observation wells, Washington, Oregon, Idaho, Montana, Wyoming, Utah, Colorado, Alaska

Identifiers: *Well data, Periodic observations.

Water-level data collected between 1961 and 1965 from a basic network of observation wells in the northwestern U. S. are presented in tabular form. Each well is identified by a local number, provided for continuity with older reports and for other use as directed by local needs, as well as a code number based on latitude and longitude. A list of numbers of U.S.G.S. water-supply papers with additional local information is presented. An additional bibliography includes water-level papers published by state and local agencies. A description of each measuring point is given. The report area includes: Washington, Oregon, Idaho, Montana, Wyoming, Utah, Colorado, and Alaska. (Knapp-USGS) W68-00812

GROUND-WATER RECONNAISSANCE OF THE SANTA BARBARA-MONTECITO ARI SANTA BARBARA COUNTY, CALIFORNIA,

U. S. Geological Survey.

K. S. Muir. U S Geol Surv Water-Supply Pap 1859-A, pp A1-A28, 1968. 28 pp, 4 fig, 2 plate, 3 tab, 9 ref.

*Groundwater, *Hydrologic data, *Water quality, *Water yield, Water wells, Aquifers, Logging (Recording), Chemical analysis, Water levels, Hydrogeology, Water able, Data collections, Groundwater basins, Water level fluctuations, Specific capacity, Hydrologic properties. Identifiers: *Well data, Water level measurements,

Santa Barbara, Cal.

In development plans for future water needs of Santa Barbara County, a reconnaissance study of the hydrology and geology of the area was made. The study area is on the south coast of Santa Barbara County between the Goleta groundwater basin on the west and the Carpinteria basin on the east. The basins are both topographic and structural depressions and contain several hundred to several thousand feet of unconsolidated Tertiary and Quaternary deposits. The principal aquifer is the Pliocene and Pleistocene Santa Barbara Formation, which is 200-500 ft thick. Wells in it flow 2-20 gpm and pumped yields of 500-1,000 gpm with sp capacities of 3-6 gpm per ft are common. Storage in the Santa Barbara area varied from 184,000 ac-ft to 178,000 ac-ft between 1959 and 1964. Safe yield in the Santa Barbara area is about 1,700-2,000 acft per yr. The water is of suitable quality for domestic and most industrial uses. Some local seawater intrusion has occurred in the upper part of the shallow alluvial deposits. (Knapp-USGS) W68-00813

THE USE OF CHEMICAL ANALYSIS OF CAVE WATERS AS A METHOD OF WATER TRACING AND INDICATOR OF TYPE OF STRATA TRAVERSED, Douglas T. Richardson.

Trans Cave Res Group of Great Britain, Symp on Cave Hydrol and Water-Tracing, Vol 10, No 2, pp 61-72, May 1968. 12 p, 3 fig, 4 tab, 11 ref, append,

Descriptors: *Tracers, *Indicators, *Chemical analysis, *Caves, *Water chemistry, Movement, Tracking techniques, Currents (Water), Water cir-culation, Sinks, Karst, Sampling, Water analysis. Identifiers: Water circulation tracing, Cave waters.

A technique is outlined for tracing the movement of waters in caves by using natural chemical constituents to distinguish waters of different sources, or different paths through different strata, to the sampling site. Sampling and analysis may be done by one man at any time during an investigation and the only field equipment needed is a thermometer, pencil, paper, and sample containers. The use of dye or radioactive tracers is not necessary. The method works best if the waters to be analyzed have moved only short distances or moved rapidly, because long contact with the same rock tends to bring all groundwaters to the same composition. (Knapp-USGS) W68-00818

Sampling,

R. N. Bathart, and Don C. Ault. Water Well J, Vol 22, No 8, pp 27-30, Aug 1968. 4 p, 1 photo.

Descriptors: *Sampling, Cores, *Drilling, On-site tests, Core drilling, Drill holes, Rotary drilling, Casings, Drilling equipment, Logging (Recording), Wells, Geologic formations.

Identifiers: *Cable tool drilling, Bailer sampling

(Wells), Spoon sampler (Wells), Sand pump.

Information gained from cuttings sampling in water well drilling is used to select screen slot size, length of screen, well diameter, and pump capacity. To obtain samples to use in predicting well per-formance and screen needs, test wells are usually drilled before production wells, or the samples may be taken from the production wells themselves, as with most domestic wells. Samples should be taken at 2-5 ft intervals and at all stratigraphic changes. In cable tool drilling, the most accurate samples are taken with a flat valve bailer or a sand pump from inside casing driven ahead of the drilling depth. In rotary drilling, samples should be splits of a complete hole cleanout taken after drilling a short distance in a cleaned hole, because otherwise sample lag and vertical sorting will contaminate the cuttings return. In either type of drilling, coring yields the best samples, but it is the most expensive method. Samples should be duplicated in case of storage or shipping damage. (Knapp-USGS) W68-00820

WATER LEVELS AND ARTESIAN PRESSURES IN OBSERVATION WELLS IN MONTANA THROUGH 1967,

U. S. Geological Survey R. G. McMurtrey, and T. E. Reed. Mont Bur of Mines and Geol Bull 65, 40 p, Mar 1968. 9 fig, 2 tab, 22 ref.

Descriptors: *Groundwater, *Water wells, *Hydrologic data, Aquifers, *Artesian wells, Data collections, Water table, Water level fluctuations, Observation wells, *Montana. Identifiers: *Water level measurements, *Well

Well data collected through 1967 are tabulated. In addition to the permanent observation wells, project observation wells are used in each areal study in Montana, and data from these wells are also available. Location maps are included for the permanent wells. Each well is assigned a number. In the tabulation each well number is followed by owner's name, type of well (water table or artesian), the geologic setting or formation, diameter, depth, altitude of measuring point, and water levels with dates of measurements. Water levels of selected wells are also presented graphically. (Knapp-USGS) W68-00822

Group 2F—Groundwater

SOME DEVELOPMENTS IN PULSE-TRAIN ANALYSIS,

English Electric Computers, Ltd.

J. D. Wilcock

Trans Cave Res Group Great Britain, Symp on Cave Hydrol and Water - Tracing, Vol 10, No 2, pp 73-98. 26 p, 10 fig, 7 ref, 4 append, disc.

Descriptors: *Tracers, *Water circulation, *Caves, *Digital computers, *Analog models, Movement, Tracking techniques, Sinks, Karst, Floods, Hydraulics, Computer models.

Identifiers: *Pulse-train analysis, Cave waters.

Because flood pulses of natural or artificial origin in the surface-water inflow to a cave system will be transmitted throughout the underground drainage network and can be analyzed at the outflow of the system, access to interiors of caves is not necessary to obtain detailed information about their hydrolo gy. Pulse-train may be analyzed by digital and analog computer techniques. The assumptions made are that water enters the cave from nonkarstic rocks, that there is I flood wave only, and that the cave model consists of sink, vadose passage, master cave, flooded zone, and resurpassage, master cave, mooted zone, and resurgence. It is then possible to construct idealized graphs illustrating changes inflow, hardness, pH, and resurgence. The analysis of output pulses is complex and the number of possible cave-passage configurations which could yield the same output pulses makes the problem an ideal one for computer solution. General methods of analog and digital computer model construction for solution of pulse-trains are discussed. An electrical analog is presented in detail and an algorithmic method for digital computers is given in a flow chart. (Knapp-USGS) W68-00823

TRACING **SWALLET** WATERS **USING** LYCOPODIUM SPORES,

Bristol University, England.

T. C. Atkinson.

Trans Cave Res Group of Great Britain, Symp on Cave Hydrol, and Water - Tracing, Vol 10, No 2, pp 99-105, May 1968. 7 p, 5 fig, 3 ref, disc.

Descriptors: *Tracers, *Indicators, *Spores, *Clubmoss, *Caves, Dye releases, Tracking techniques, Currents (Water), Water circulation, Sinks, Karst, Sampling (England), Identifiers: Cave waters, Water circulation tracing, Dyed spores.

A method for tracing the movement of waters in caves by using dyed Lycopodium spores is described. The spores are of about the same density as water and do not tend to settle out. They may be dyed various colors so that several sources of water may be traced at one time to one or more sampling sites. The use of 1 kg of spores per mil per 10 cfs discharge per 10% of flow at the most likely discharge is suggested. Recovery was about 1 spore per million field tests. (Knapp-USGS) W68-00824

SOME NOTES ON THE USE OF CALCIUM HARDNESS MEASUREMENTS IN STUDIES OF CAVE HYDROLOGY,

Hull Univ., England. Alistair F. Pitty.

Trans Cave Res Group of Great Britain, Symp on Cave Hydrol and Water - Tracing, Vol 10, No 2, pp 115-120, May 1968. 6 p, 3 fig, 2 tab, 8 ref.

Descriptors: *Tracers, *Indicators, *Chemical analysis, *Caves, *Water chemistry, Movement, Tracking techniques, Currents (Water), Water circulation, Karst, Sampling, Water analysis, Hardness (Water), Calcium carbonate, Sinks. Identifiers: Water circulation tracing, Cave waters.

Patterns in the variation in the amount of calcium carbonate in cave waters may be used to draw inferences about underground stream connections and water sources. The factors important in causing the differences are dilution by runoff from noncalcareous outcrops, and the variation of carbon dioxide in the soil which causes a close relationship between hardness fluctuations and antecedent air temperatures. The study of the hardness-temperature relationship affords a means of estimating the time of percolation of water in a limestone mass. If their mean hardness values are substantially different, it is possible to estimate proportions contributed by each of 2 tributaries to their combined flow. Examples are given of observations in caves in Derbyshire and northwestern Yorkshire. (Knapp-USGS) W68-00826

GROUND WATER -- A **DEPENDABLE** RESOURCE,

U. S. Geological Survey. W. B. Langbein.

Ground Water Age, Vol 2, No 12, pp 12-13, Aug 1968. 2 p, graph.

Descriptors: *Water supply, *Water level fluctua-tions, *Water management (Applied), *Observation wells, *Water levels, Hydrologic data, Data collections, Water wells, Groundwater. Identifiers: *Periodic observations.

Graphs of records of fluctuations of water levels in key observation wells in the U.S. between 1930 and 1960 are compiled. Scales are chosen to emphasize trends. The effects of heavy pumping for water supplies are shown in downward trends in 3 of the graphs. There is, however, no national overall trend in water levels. That is, there is no country-wide 'falling water table' as has often been posed as a na-tional calamity. Artificial recharge for water storage is proposed as a method of water-supply management. Proper water resource management will prevent any nationwide groundwater problems from developing. (Knapp-USGS) W68-00827

WATER LEVELS IN OBSERVATION WELLS IN NEBRASKA, 1967,

U. S. Geological Survey.

C. F. Keech.

Nebr Univ Conserv and Surv Div, Water Surv Pap 23, 85 p, June 1968. 21 fig, 49 graphs, 1 tab.

Descriptors: *Water levels, *Observation wells, Nebraska, Precipitation intensity, Hydrographs, Data collections. Identifiers: *Recording gages.

Graphics accompany the statistical tables describing the water-level measurements in 531 observation wells, in Nebraska made in 1967. All measurements are in feet below land-surface datum at well sites. In the customary well numbering system, each well is numbered according to its location within the land subdivisions of the U.S. Bureau of Land Management. During 1967, precipitation averaged 22.20 in. which would have been a significantly low value were it not for the unusually heavy rainfall in June. Locations of 27 recording gages are shown and hydrographs for these gages are arranged by alphabetical order, according to counties. Included is a listing of state reports containing water-level measurements. Records for representative Nebraska wells are included in the USGS publications listed for 5-year intervals from 1935 through 1961. Llaverias-USGS) W68-00831

A METHOD OF CALCULATION OF OPTIMUM REMOVAL OF THE EARTH HEAT BY THER-MAL WATERS PUMPING APPLYING MODELLING,

Acad Sci of Ukranian SSR, Inst Geol Sci.

V.I. Lyalko. Bull Int Ass Sci Hydrol, Vol 13, No 2, pp 85-91, June 1968. 7 pp, 1 tab, 7 ref.

Descriptors: *Thermal water, *Water wells, *Water yields, *Analog models, Thermal power,

Heat transfer, Convection, Conduction, Aquifers,

Model studies.
Identifiers: *Thermal water wells, *Heat yield, USSR, Thermal water yield.

The amount of heat that may be removed continuously from deep thermal aquifers in the western Crimea, USSR, was calculated by the use of a flow net drawn with the aid of an electroconductivepaper analog model. The area of investigation is the Novoselevksy structural high, which has a geothermal gradient of 5.8 deg C per 100 m. At discharge the thermal waters have a temperature of 40-55 deg C and discharge 200-1,500 cu m per day. The aquifer, which is composed of sandstone and conglomerates, is 70 m thick and 700-1,300 m deep, overlain by clay and underlain by Paleozoic slates, sandstones, and limestones. Recharge is estimated to be 16.5 million cu m per yr. The analog model included proposed wells located near potential consumers. When the maximum drawdown allowed was 100 m, the predicted yield of heat was 28,588 kkcal per sec. The main type of heat transfer in the aquifer is convective, and this must be taken into account in any pumping program. (Knapp-USGS) W68-00836

UNSTEADY MOVEMENT OF FRESH WATER IN THICK UNCONFINED SALINE AQUIFERS, Baghdad Univ., Iraq.

Madhi S. Hantush.
Bull Int Ass Sci Hydrol, Vol 13, No 2, pp 40-60,
June 1968. 21 pp, 5 fig, 23 ref.

Descriptors: *Saline water-freshwater interfaces, *Unsteady flow, *Mathematical models, *Approximation method, Encroachment, Groundwater movement, Synthetic hydrology, Equations, Saline water systems, Recharge, Pumping, Water table, Seepage.

Identifiers: *Fresh water lenses, Interface movement, Error function.

Approximate expressions for the growth and decay of fresh-water lenses have been obtained for several flow situations. Lenses are formed in unconfined saline aquifers by deep percolation of rainfall, artificial recharge, seepage from irrigation waters, and injection of fresh water through wells. Approximate differential equations are derived in terms of depth of the salt-freshwater interface below the initial position of the salt-water table. Equations are solved for the cases of lenses beneath rectangular recharge areas, infinite-strip recharge areas, and injection wells. The aquifer forms considered are: effectively infinite aquifers, semi-in-finite coastal aquifers, closed semi-infinite aquifers, and finite-width coastal aquifers. Equations are also solved for drained or pumped lenses in the same types of aquifers, using various drain geometries. These approximations may be used in planning the extraction of usable water from such flow systems. The utility of the equations is enhanced by their use with readily available tabula-tions of error function solutions. (Knapp-USGS) W68-00838

THE USE OF VARIATIONAL METHODS AND OF ERROR DISTRIBUTION PRINCIPLES IN GROUNDWATER HYDRAULICS, Academy of Sciences, Berlin, West Germany. P. Mauersberger. Bull Int Ass Sci Hydrol, Vol 13, No 2, pp 169-178, June 1968. 10 pp, 29 ref.

*Mathematical studies, Descriptors: squares method, *Groundwater movement, *Laplaces equation, *Dupuit-Forchheimer theory, Approximation method, Analytical techniques, Darcys law, Water table, Drawdown, Soil water movement, Groundwater, Porous media. Identifiers: *Variational methods, *Error distribu-

Mathematical techniques are presented to solve problems of 3-dimensional steady-state unconfined

groundwater flow, with the assumption that Dar-cy's law is valid. As no use is made of the Dupuit-Forchheimer approximation, the shape of the free surface and the velocity potential must be determined simultaneously as a non-linear boundary value problem. To demonstrate the use of a variational method and of error distributional principles, the simplest possible case---the gravity flow of incompressible, homogeneous groundwater toward a circular well completely penetrating an isotropic homogeneous inelastic aquifer resting on a horizontal impermeable substratum---is in-vestigated. Digital computers are being used to study the applicability and usefulness of these methods to field hydrologic studies. (Knapp-USGS) W68-00839

UNSTEADY FLOW OF GROUNDWATER AND DISPERSION IN GROUNDWATER MOVE-

Wisconsin Univ., Water Resources Center. Peter L. Monkmeyer, and John A. Hoopes. Project No. OWRR A-005-Wis.

Descriptors: Aquifer characteristics, Aquifers, Dispersion, Drawdown, Dupuit-Forchheimer Theory, Groundwater movement, Hydraulic con-Auctivity, Mathematical models, Porous media, Saturated flow, Sound waves, Specific yield, Streambeds, Surface-groundwater relationships, Theis Equation, Unsteady flow.

The investigation has been carried out in four parts. (1) For the two-dimensional problem of an aquifer connected to a stream, general integral solutions and also large and small time, close form, approximations for the head distribution have been obtained using potential theory. Numerical solutions to the Dupuit equation for unsteady, unconfined flow toward a well have been obtained. The range of validity of the Theis equation, and a 'curve matching' technique for the determination of aquifer characteristics is presented. (2) For one-dimensional, unsteady flow toward a clogged streambank in a semi-infinite, confined aquifer, theoretical expressions for the head distribution have been obtained. For these results a curve matching technique has been developed to determatching technique has been developed to determine aquifer characteristics from observation well data. (3) A theory has been developed which describes the propagation of pressure waves through a fully or partially saturated porous medium. This theory shows the permeability to be frequency dependent. (4) A solution for the distribution of providing the propagate of the solution of the distribution of providing the solution of the distribution of the solution tribution of a contaminant in one-dimensional flow through a layered or continuously graded porous media has been obtained. Exact solutions have also been obtained which include the combined effects of longitudinal and lateral dispersion in a layered media. (Murray-Wisc) W68-00861

TEMPERATURE STUDY OF THE SURFACE WATER - GROUND WATER RELATIONSHIP, Clemson Univ., Clemson, South Carolina.

Albert G. Law.

Project Completion Report, Water Resources Research Institute, Clemson University, 33 p, 5 fig,

Descriptors: *Water temperature, *Aquifer characteristics, *Surface ground water relationships, Effluent streams, Induced infiltration, Ground water movement.

Several investigators have reported temperature differentials on the order of 20 deg F between a stream and a hydraulically connected aquifer during induced infiltration operations. Since viscosity ing mourced intitration operations. Since viscosity increases about 1 1/2 per cent for each 1 deg F decrease in water temperature, this may have a significant effect on the flow rate. A variable viscosity has the effect of causing the coefficient of permeatics that the coefficient of permeatics the coefficient of the c bility to be variable in the ground water flow equation. A field study was made of ground water head and temperature fluctuations in response to a change in stream level. While no definite conclusions could be drawn, it was observed that for effluent stream conditions and a rise in air temperature above the ground water temperature, the ground water temperature increased and the stream temperature decreased. This is attributed to a decrease in viscosity and an increased ground water flow of the ground water to the stream. An unsuccessful attempt was made to obtain a solution to the one-dimensional ground water flow equation in response to a linear change in stream stage when the permeability is changing due to temperature or some other reason. (Author) W68-00892

THE PIEZOMETRIC SURFACE OF THE COASTAL PLAIN AQUIFER IN GEORGIA, ESTIMATES OF ORIGINAL ELEVATION AND LONG-TERM DECLINE,

Georgia Univ., Athens. Robert E. Carver.

Southeastern Geology, Vol 9, No 2, June 1968, pp. 87-99, 13 p, 3 fig, 1 tab, 26 ref.

Descriptors: *Piezometric surface, Static head, Artesian pressure, Hydraulic profile, Pressure gradient, *Artesian water wells, *Ground water level, *Aquifers, Water demand, Water pressure decline. Recharge areas, Water management practices, Water supply, Depression cones. Identifiers: Georgia, Coastal Plain aquifer, The

Floridan aquifer, Southeast U.S., Savannah, Ga., Brunswick, Ga., Augusta, Ga.

The Coastal Plain aquifer in Georgia has deep cones of depression in the piezometric surface around centers of pupulation and industrial activity resulting from over pumping. Decline of the aquifer pressure near the Atlantic Coast is well known. The pressure decline for the Coastal Plain aquifer as a whole is evaluated. Published reports, 1898, 1908, and 1915, on artesian wells in Georgia provide data to determine the original piezometric surface of the aquifer in an area defined by a line joining Augusta and Fort Gaines to the Atlantic Coast and Florida border. The original piezometric surface compared with the piezometric surface in 1942 (Warren) indicates significant aquifer pressure changes since 1880 with a pressure head decline of 40 feet in the area north of Tifton, Georgia. Comparison of the original piezometric surface indicates a pressure decline of about 35 feet near the Atlantic Coast and 75 feet north of Tifton between 1880 and 1966. The heavy pumping around major municipal and industrial centers on the Atlantic Coast has long-term far-reaching effect and suggests a need for more extensive monitoring of the aquifer pressures. (WRC-Ga) W68-00900

NEW DRILLED WATER WELLS IN HAMPSHIRE. New Hampshire Univ., Durham.

For primary bibliographic entry see Field 03B. For abstract, see .

UNSTEADY UNCONFINED FLOW TO GRAVI-TY WELLS,

Leeds Univ., Dept. of Civil Engineering, Leeds, En-

gland. J. A. Fox, and I. Ali. Inst Civil Eng Proc, Vol 40, pp 451-469, Aug 1968. 19 p, 16 fig, 2 tab, 9 ref.

Descriptors: *Groundwater movement, *Drawdown, *Unsteady flow, *Model studies, *Mathematical models, Digital computers, Theoretical analysis, Synthetic hydrology, Theis equation. Identifiers: *Wave-motion equation, *Unsteady unconfined drawdown, Drawdown tank study, Steinbrenner equation.

Shallow-water wave theory was used to describe unsteady flow to wells through porous media. A serious shortcoming of theoretical treatments of transient flow in porous media is the assumption that water is yielded instantaneously in drawdown; this analysis is not completely free from defect. The solution involves integration of 2 quasilinear hyperbolic partial differential equations. A digital computer method was used and a flow chart of the program is included. The solution was checked in an experimental tank in the shape of a 15 deg sector of a 12 ft dia circle, instrumented and with facilities for production of specific boundary conditions. Depth to water was continuously measured along a radius. The porous medium was 5/8 in. stone chips. Agreement between experimental and theoretical values was good except in the immediate vicinity of the well where the groundwater surface was strongly curved. (Knapp-USGS) W68-00957

THEORETICAL ANALYSIS OF REGIONAL GROUND WATER FLOW 3. QUANTITATIVE INTERPRETATIONS,

Canada Dept of Energy, Mines and Res and Univ of Calif, Berkeley, Dept of Civil Eng. R. A. Freeze, and P. A. Witherspoon. Water Resources Res, Vol 4, No 3, pp 581-590, June 1968. 10 p, 3 fig, 13 ref.

Descriptors: *Groundwater, *Digital computers, *Watersheds (Basins), Groundwater basins, Drainage, Permeability, Flow nets, Water table, Recharge, Discharge (Water), Surface-groundwater relationships, Mathematical studies. Identifiers: *Drainage basin characteristics, Natural basin yield.

The natural yield of a ground water basin can be calculated from a quantitative analysis of the flow net obtained from a digital computer solution to a numerical mathematical model of the basin. The natural yield is a unique property of the basin and can be considered as a measure of the ground water recharge to the basin and a conservative estimate of the safe yield. Rates of ground water recharge and discharge vary from place to place throughout the areal extent of a basin; a quantitative analysis can be used to determine the position of concentration. Quantitative interpretation of ground water flow nets can play an important role in the calculation of basin-wide water balances due to the interrelationships between ground water recharge and infiltration at one end of the flow system and ground water discharge, evapotranspiration, and stream baseflow at the other. (Knapp-USGS) W68-00959

GEOHYDROLOGICAL RECONNAISSANCE IN UPPER VOLTA,

Louis Berger, Inc, East Orange, N J. W. H. Bierschenk.
Ground Water, Vol 6, No 1, pp 29-40, Jan-Feb 1968. 12 p, 6 fig, 11 photo, 3 tab, 4 ref.

Descriptors: *Groundwater, *Water wells, *Hydrologic data, *Climatic data, *Laterites, Aquifers, Water quality, Hydrogeology, Water sources, Water yield, Shallow wells, Surveys. Identifiers: *Upper Volta, *Water resources inventions. tory, Dug wells.

A water resources inventory of the north-central part of Upper Volta was made and a program of water development by large-diameter dug wells was recommended. In the study area, from north to south the rainfall ranges from 500 mm to 1,200 mm, evaporation from 3,385 mm to 1,945 mm, and temperatures from 34 deg C to 30 deg C. The surficial rocks over much of the area lateritic, generally ferruginous, hard, and cemented. The bedrock is mainly granite with lesser amounts of metamorphics. The 'under laterite' study and clayey materials, which are the weathering products of igneous and metamorphic rocks, are the principal aquifers and yield small quantities of water adequate for domestic and stock use. The thin water-bearing zones are tapped only by large-diameter dug wells which produce as much as 2,000 1 per hr. Bedrock may yield a small quantity

Field 02-WATER CYCLE

Group 2F-Groundwater

of water from fractures. Water is not available in sufficient quantity or quality to raise standards of living in the 631 villages in the area. Most of the immediate water needs can be met by constructing more large-diameter dug wells. (Knapp-USGS) W68-00964

LOGGING IN **GROUNDWATER** WELL HYDROLOGY

U S Geological Survey, Denver. For primary bibliographic entry see Field 07A. For abstract, see W68-00968

WATER RESOURCES OF ORANGE COUNTY. FLORIDA,

U. S. Geological Survey. For primary bibliographic entry see Field 04B. For abstract, see. W68-00976

GROUND WATER RESOURCES OF THE NORTHERN POWDER RIVER VALLEY, SOUTHEASTERN MONTANA,

U.S. Geological Survey For primary bibliographic entry see Field 04B. For abstract, see . W68-00977

HYDROLOGY OF THE METAMORPHIC AND IGNEOUS ROCKS OF CENTRAL CHESTER COUNTY, PENNSYLVANIA,

U. S. Geological Survey For primary bibliographic entry see Field 04B. For abstract, see W68-00978

GROUNDWATER RECHARGE, DYNAMICS OF GROUND WATER FLOW SYSTEMS, GROUND WATER FLOW METHODS OF DELINEATING DRIFT AQUIFERS, Michigan State Univ, East Lansing. SYSTEMS, GLACIAL

Samuel B. Romberger, Robert Ehrlich, and William J. Hinze. Termination Rep, Dep Geol, Mich State Univ, June 1967. 65 p, 23 fig, 7 tab.

Descriptors: Ground water, *Groundwater recharge, Geochemistry, Water analysis, Weather-*Groundwater ing, *Electric analogs, Geophysics, Hydrogeology, *Groundwater flow, Aquifers, Glacial drift, Groundwater movement, *Leaching, *Water quality, Organic matter.

Identifiers: Geophysical prospecting, *Gravimetric prospecting.

Laboratory and field studies show organic materials occurring in natural waters have a significant control on the weathering and transport of mineral matter. Up to 60% of cations such as Mg and Ca are organically complexed in natural streams, with the effect increasing with organic content. The data suggest most dissolved material in subsurface waters is derived from the first few feet of soil and wathered rock from the interaction of organic acids, derived from the soil horizon, and mineral matter. Low permeability horizons rich in clay and silt have a beneficial effect on the quality of descending waters. Analysis of an electric analog model of the ground-water system of the Saginaw formation revealed several significant facts useful in planning water resource developments. Analysis of results of gravity surveying shows negative gravity anomalies generally are associated with buried bedrock valleys and can be isolated from other anomalies by the least squares method. Therefore, the gravity method can be used as a rapid reconnaissance technique for locating buried valleys which are favorable areas for the occurrence of glacial drift aquifers. W68-01013

2G. Water in Soils

SOIL HYDRAULIC CONDUCTIVITY AS AFFECTED BY SODIC WATER,
Texas A and M University, College Station, Tex.
Bruno Yaron, and Grant W. Thomas.

Water Resources Res, Vol 4, No 3, pp 545-552, June 1968. 8 p, 6 fig, 3 tab, 12 ref.

Descriptors: *Hydraulic conductivity, Water quality, Permeability, Pervious soils, Porosity, *Saturated flow, Soil chemical properties, Soil water movement, *Soil water, Irrigation, Bentonite, Expansive clays, Expansive soils, Ion exchange, Leaching.

Identifiers: *Sodic water, Swelling clays, NAbentonite, Experimental soil systems.

The hydraulic conductivities of mixtures of soil and glass beads in columns were determined during the flow of dilute sodium-calcium solutions through the mixtures. Flow was continued until equilibrium was achieved. A curvilinear decrease in hydraulic conductivity was found as the exchangeable sodium approached equilibrium. The shape of the curve depended on the nature of the soil and the cationic composition and total salt content of the solutions. The hydraulic conductivity became constant only when a constant exchangeable sodium content was achieved along the soil column. A semiempirical method of predicting the hydraulic conductivity was developed. Agreement between calculated and observed values was found to be reasonably good. (Knapp-USGS) W68-00665

THE COLLECTION OF NATURAL SOIL PROFILES FROM ARID REGIONS--A FIELD METHOD AND MANUAL,

Netherlands, Agricultural University, Wageningen, Department of Tropical Soil Science and Department of Regional Soil Science.

T. de Meester, and J. Bouma. Netherlands J of Agr Sci, Vol 15, No 1, pp 63-74, Feb 1967. 12 p, 6 fig, 1 tab, 22 ref.

Descriptors: *Soil profiles, *Arid lands, *Soil investigations, Cost-benefit ratio, *Methodology, *Sampling, Soil horizons, Calcareous soils, Clays, Soil analysis, Economic feasibility, Transportation, On-site investigations, Geomorphology. Identifiers: *Soil peels, *Preparation techniques.

The techniques described were developed and successfully applied to the semi-arid Konya plain in central Anatolis, Turkey. A short review of soilpeeling techniques was given. Modified techniques for soils of arid regions with respect to calcareous and clayey soils were given. The advantages and the manual of the field procedures for soil peels from a vertical wall were explained. Advice was given on how to transport soil peels without damage. An example was given for the calculation of the production cost of one soil profile peel in a Middle East Country. (Blecker-Ariz) W68-00689

SOIL-WATER POTENTIAL: DIRECT MEASUREMENT BY A NEW TECHNIQUE, Australia, CSRO, Division of Plant Industry, Canberra, Aust. Cap. Territory. A. J. Peck, and R. M. Rabbidge. Science, Vol 151, No 3716, pp 1385-1386, March 18, 1966, 2p. 156.

18, 1966. 2 p, 1 fig.

Descriptors: *Soil water, *Free energy, *Potentiometers, *Solutes, Instrumentation, Soil water movement, Unsaturated flow, Atmospheric pressure, Osmotic pressure, Thiems equation, Equilibrium, Pressure measuring instruments. Identifiers: *Unsaturated soils.

A problem in studies of water relations in unsaturated soils is the accurate measurement in situ of the potential of soil water. This potential is negative with respect to that of the standard reference state: pure free water at atmospheric pressure. The difference between the equilibrium pressure and the osmotic pressure of a solution, physically con-strained in a container surrounded by unsaturated soil, is numerically equal to the specific free energy of the soil water. This difference is a measure of the potential of the soil water. To determine soil-water potential, pressure measurements were obtained. Instruments were designed and constructed to apply this principal. (Blecker-Ariz) W68-00699

CLIMATE AND SOIL MOISTURE EXTRACTION -- GILAT, ISRAEL, Environmental Sci. Services Administration. En-

Environmental Data Serv., Tempe, Ariz.; Israel, Volcani Inst. of Agr. Res., Rehovot.
Milton L. Blanc, and Obadiah P. Cohen.
Agr Meteorol, Vol 4, No 5, pp 367-371, Sept 1967. 5 p, 2 fig.

Descriptors: Arid lands, *Soil moisture meters, Winter, *Alfalfa, Precipitation (Atmospheric), *Evapotranspiration, Wilting point, Plant growth, Irrigation practices, Neutron absorption, Data collections, *Meteorological data, *Sprinkler irrigation, Wetting, Diurnal, Water spreading, Soilwater-plant relationships, Loess. Identifiers: Israel, Indicator plants, *Plots.

The goal of the project was to publish a detailed record of daily soil moisture extraction and attendant meteorological conditions over a 2 year period. Annual precipitation, occurring during the winter at the Gilat Experiment Station, averages about 200 mm. Alfalfa plants were used as indicator plants. The 'wet' plow was irrigated to maintain frequent periods of potential or near potential rates of evapotranspiration. The dry plot was permitted to approach the wilting point toward the end of each irrigation cycle. Each alfalfa plot was represented by four access tubes for the neutron soil moisture probes. The bare plots contained two tubes. The tubes penetrated to a depth of five meters. (Blecker-Ariz) W68-00705

TRACERS DETERMINE MOVEMENT OF SOIL

MOISTURE AND EVAPOTRANSPIRATION, Heidelberg Univ., Deutscher Wetterdienst, Gies-Landwirtschaftliche Untersuchungsund Forschungsanstalt, Speyer. U. Zimmermann, K. O. Munnich, and W. Roether.

Science, Vol 152, No 3720, pp 346-347, April 15, 1966. 2 p, 1 fig, 1 tab.

Descriptors: *Rain water, *Soil water movement, *Radioactive dating, *Surface-groundwater relationships, *Tracers, Water table, Soil moisture, Evapotranspiration, Groundwater recharge, Capillary water, Deuterium, Tritium, Tracking techniques, Water balance, Sampling, Seepage, Diffusion, Radioisotopes. Identifiers: Groundwater table.

The downward movement of soil water is a layered one. New rainfall on the surface of the soil pushes the old water downward. A single 'rainfall' labeled with a hydrogen-isotope tracer forms a tagged layer of water that moves downward as a distinguishable water mass between the older rainwater below and the younger rainwater above. Samples of soil are taken and isotopic analysis of the soil moisture gives the vertical distribution of the tracer. For any period of time that is not too short, one can prepare a balance, for the soil above the tracer mark, between incoming rain, evaporation loss and water that will eventually reach the groundwater table. An advantage of the method is that it provides detailed information on the water balance without disturbance of the natural conditions. (Blecker-Ariz) W68-00706

CERTAIN FLOWS OF AIR AND WATER IN SANDS DURING INFILTRATION,

U. S. Geological Survey. W. O. Smith, H. W. Olsen, and R. A. Bagnold. Soil Sci, Vol 101, No 6, pp 441-449, June 1966. 9 p, 6 fig, 1 tab.

Descriptors: *Infiltration, *Permeability, *Air masses, Rainfall, Field capacity, Atmospheric pressure, Discharge measurement, Sands, Irrigation, Wetting, Flow rates, Model studies, Capillary ac-tion, Soil water movement, Hydraulic conductivity. Identifiers: Bulk water, Confined air, Bulk air.

Experiments were designed to simulate successive infiltration such as might occur in a sequence of rainfalls, or irrigations into a soil wetted to field capacity. They involved the downward flow of alternate masses of air and water through a long vertical cylindrical column of sand. Air masses entered the column under atmospheric pressure in intervals of specified duration between the introduction of successive water masses. Bulk air encountered by infiltration water masses was transported down the column by the moving liquid. Air was discharged continuously from the column, even though it was introduced periodically in bulk masses. Transported air was carried down within the bulk water in the form of entrapped air bubbles. Volumes of air discharged per cycle were considerably less than would occur if piston flow was the dominant process. Because the transported air was predominately entrapped, confined air pressures were negligible, and effect of air on infiltration rates was largely the effect of entrapped air on permeability of the sand. (Blecker-Ariz) column by the moving liquid. Air was discharged

MORPHOLOGICAL AND GENETIC SEQUENCES OF CARBONATE ACCUMULATION IN DESERT SOILS, Soil Conserv. Serv, University Park, New Mexico; Univ. of Calif., Riverside, Dept. of Soils and Plant Nutr., Soil Conserv. Serv, Lincoln, Nebraska, Soil

Survey Laboratory. L. H. Gile, F. F. Peterson, and R. B. Grossman. Soil Sci, Vol 101, No 5, pp 347-360, May 1966. 14 p, 7 fig, 4 tab.

Descriptors: *Carbonates, *Sierozems, *Arid lands, Alluvium, *Soil profiles, *Geomorphology, Soil texture, Sediments, Gravels, New Mexico, Geologic time, Soil properties, Calcareous soils, Carbon radioisotopes. Identifiers: Pebble

Horizons with authigenic carbonate are common in soils of arid regions and in many of these soils are the most prominent horizon. Authigenic carbonate horizons of many desert soils of southern New Mexico have formed in thick, well-drained alluvium. They have characteristic morphologies that depend primarily on texture of parent material, age of soil and geomorphic history of the soil. Carbonate horizons formed in gravelly sediments display a different morphological sequence, with continued accumulation of carbonate, as compared with horizons formed in nongravelly sediments. A genetic basis for the morphological sequences is supported by the occurrence of features common to morphologically more simple stages of car-bonate accumulation in more complex horizons, morphologically determined, only on land surfaces shown to be older by geomorphic evidence. (Blecker-Ariz)
W68-00718 and by occurrence of the more complex stages, as

GEOGRAPHIC-GENETIC PATTERNS IN THE DEVELOPMENT OF DESERT-STEPPE AND DESERT SOILS OF THE U.S.S.R., USSR Dokuchayev Soil Institute.

Soviet Soil Sci, Vol 3, pp 243-253, March 1966. 11 p, I fig, I tab.

Descriptors: *Soil types, *Sierozems, *Geographic regions, Clays, *Grasslands, *Annual succession,

Soil profiles, Geomorophology, Turf, Humus, Humic acid, Clay minerals, Succession, Gypsum, Climatic zones, Topography, Soil formation, Soil chemical properties, Vegetation.
Identifiers: U.S.S.R., *Zonal succession, Bioclimatics.

matic, Genesis.

Ideas concerning genesis and geography of Desert-Steppe and Desert soils flow from theories concerning zonal succession of bioclimatic conditions. Many areas of soil development are used to contrast differences of these two soils. Areas of sod cover, humic acid content, distribution of clay particles and kinds of clay minerals present were discussed. The nature of the gypsum horizons tell how recently and newly formed the soils are. Climate is discussed in connection with distribution of the soils. In the zone of Desert-Steppe Brown soils, bioclimatic conditions have much in common with conditions surrounding the development of Desert soils. Variation of Steppe soils is explained by influences of soil-forming parent materials, relief, and redistribution of moisture under modern climatic conditions. Local variations in factors of soil formation and soil characteristics which they govern do not always lead to appearance in the soils of sufficiently clear particular morphological and chemical traits that are required for sub-dividing soils into independent groups or subgroups. (Blecker-Ariz) W68-00719

EFFECT OF WATER APPLICATION RATE ON LEACHING.

Utah State University.
Jack Keller, and Jose F. Alfaro. Soil Sci, Vol 102, No 2, pp 107-114, August 1966. 8 p, 10 fig, 1 tab.

Descriptors: Laboratory equipment, Saturation, Chlorides, Porosity, *Leaching, Dispersion, Hydrodynamics, Diffusion, *Salinity, Soil water movement, *Effluents, Salts, Mathematical movement, *E models, Wetting.

An applicator was designed to apply water uniformly at any constant rate between 0.1 cm and 25.0 cm per hr to the surface of soils contained in 25.0 cm per nr to the surface of some contained in specially prepared covered pots. Three initial soil salinity levels - EC of 8, 12, and 16 mmhos were used on Nibley sitly clay loam. At any time after discharge began, the volume of water applied ex-ceeded the volume of effluent by an almost fixed increment. The sigmoid shape and skewness of the oncentration curves resulted from either hydrodynamic dispersion caused by variations in pore water velocity or from molecular diffusion or both. The relatively high leaching efficiencies at all applications and the increasing efficiency with decreasing application rate was associated with the existing application rate was associated with the existing unsaturated flow. The possible mechanisms which operated to increase the leaching efficiency as application rates decreased where a reduction in hydrodynamic dispersion and an increase in transverse molecular diffusion resulting in a reduction in dilution of the initial soil water. (Blecker-Ariz) W68-00726

RECLAMATION OF THE NORTHERN PART

RECLAMATION OF THE NORTHERN PART OF THE NILE DELTA AREA, Cairo Univ., Faculty of Engineering, Irrig. and Hydraul. Dept.; U.A.R. Egyptian Gen. Org. for Land Develop.; and Projects Planning Division. M. Shahin, and Z. Arnout. Intern Comm on Irrig and Drainage, Sixth Congress, Vol 2, pp 187-218, Question 19, 1966. 32 p, 15 fig, 3 tab.

Descriptors: Dams, *Drainage systems, *Irrigation system, Canals, Water storage, Soil texture, Ground water, Clays, Seepage, *Saline soils, *Land reclamation, Topography, Meteorological data, Soil properties, Alkaline soils, Water quality, Soil profiles, Mechanical properties, *Leaching, Crop production, Ions. Identifiers: United Arab Republic, Nile River.

The land under study was high in clay content and concentration of salts. A detailed description was given of the procedure followed in reclaiming a vast area. This included investigation of the mechanical and chemical properties of the soil, depth of water table, sources of irrigation water and quality of irrigation and drainage water. Alignment of irrigation and drainage waters, different ment of irrigation and drainage systems, different classes of irrigation and drainage ditches, crop rotation adopted to the land after reclamation and crop requirements were studied. Profiles of virgin soils were compared to profiles of soil that had been leached for one, two and three years. Com-parisons were made on clay content, fine sand and silt, total soluble salts and calcium carbonate content. From the investigation it was found that study of the soil profile in areas under reclamation is highly important for setting up the plan of soil desalinization. A relation between reclamation age and productivity for each type of soil, and in each soil type between total soluble salts and berseem clause and descriptions. clover yield was studied. (Blecker-Ariz)

VEGETATION AND SOILS OF ALKALI SAGEBRUSH AND ADJACENT BIG SAGEBRUSH RANGES IN NORTH PARK, COLORADO.

U.S. Department of Agriculture Soil Conservation Service, Glenwood Springs, Colorado. D.R. Robertson, J. L. Nielsen, and N. H. Bare. J Range Manage, Vol 19, No 1, pp 17-20, Jan 1966. 4 p, 3 fig, 2 tab.

Descriptors: Colorado, Soil structure, Soil texture, Soil-water-relationships, *Plant growth, *Sagebrush, Ranges, *Clays, *Loam, Root zone, *Soil surveys.

In North Park, Colorado, the sagebrush plant community stands out in sharp contrast with other kinds of sagebrush rangeland. The species is alkali sagebrush (Artemisia longiloba (Osterhout) Beetle). The study described the vegetation and soils occurring on this range site, and compared both to the vegetation and soils on adjacent ranges having a cover of big sagebrush (Artemisia tridentata Nutt.). Soil samples, soil profiles, plant composition and production were determined for each of the thirteen sites. A marked difference occurred in In North Park, Colorado, the sagebrush plant comthe thirteen sites. A marked difference occurred in plant composition, total annual plant yield and soil characteristics. The Claypan range was the result of a shallow, restrictive soil zone which prohibited the penetration of all but the finest roots. The alkali sagebrush plant, being drouth adapted, could survive under this condition. The big sagebrush community occurred only on moderately deep to deep mountain loamy soils where deep root penetration was possible. After range sites and soils were correlated it was possible to determine space it. lated, it was possible to determine range sites from the soil survey. (Blecker-Ariz) W68-00735

BOUNDARY FLOW IN LABORATORY PER-MEAMETERS USED TO STIMULATE RECHARGE BY CYCLIC WATER SPREADING,

Arizona University, Tucson. B. K. Worcester, T. H. McIntosh, and L. G. Wilson.

Water Resources Res, Vol 4, No 3, pp 591-595, June 1968. 5 p, 4 fig.

Descriptors: *Permeameters, *Hydraulic conductivity, *Soil water movement, *Groundwater recharge, *Water spreading, *Laboratory tests, Conductivity, Electrical conductance, Scaling, Sands, Infiltration, Piezometry, Model studies, Porous media, Darcy's law, Boundaries (Surface), Flooding (Intentional inundation), Flow measurement, Prying ment, Drying.

A laboratory permeameter design is presented to A laboratory permeameter design is presented to facilitate partitioning the relative contributions of flow in the boundary and inner zones on the hydraulic conductivity values of soils. This permeameter was used to evaluate the potential contribution of boundary flow to the hydraulic conductivity under a cyclic flooding and drying regime.

Field 02—WATER CYCLE

Group 2G—Water in Soils

For a 2 millimeter sand the hydraulic conductivities were consistently lower in the outer zone compared to those for the inner matrix region. Conversely, in trials using Mohave fine sandy loam, the hydraulic conductivities for the boundary region were consistently higher than those for the inner region. The divergence between flow rates of the inner zone and boundary zone were greatest during the flooding period. The changes in hydraulic conductivity within a flood cycle and with a number of flood cycles, for both matrix zones tended to be similar and paralles, although of different magnitude. A laboratory permeameter design is presented. (Affleck-Aríz) W68-00737

SOIL HYDRAULIC CONDUCTIVITY AS AFFECTED BY SODIC WATER,

Texas A and M University, College Station; Volcani Institute of Agriculture, Rehovot, Israel Bruno Yaron, and Grant W. Thomas. Water Resources Res, Vol 4, No 3, pp 545-552,

June 1968. 8 p, 6 fig, 3 tab.

Descriptors: *Hydraulic conductivity, *Alkali water, Chromatography, *Cation exchange, *Soil properties, Irrigation water, Soil chemistry, Water water, Chromatography, *Cation exchange, Water properties, Irrigation water, Soil chemistry, Water quality, Sodium, Calcium, Conductivity, Magnesi-Parmeability, Electrolytes, Leaching, Equilibrium.
Identifiers: Soil columns, Base exchange.

The hydraulic conductivities of soil-glass bead mixtures in chromatographic columns were deter-mined during the flow of dilute sodium-calcium solutions through the mixtures. The purpose of the experiment was to find the progressive decrease of hydraulic conductivity as the exchangeable calci-um and magnesium in the soil was replaced by the sodium in the percolating solution. The upper layer of the soil became saturated with sodium much faster than the lower part, but as might be expected, this did not control the hydraulic conductivity of the water. Rather it was found that the relative hydraulic conductivity was related to the mean exchangeable sodium percentage of the whole column. The data from the soil columns was used to calculate expected relative hydraulic con-ductivity. Agreement between calculated and observed values was found to be reasonably good. The results suggest that soil properties and the composition and amount of solution (irrigation water) applied to the soil can be measured and hydraulic conductivities estimated. (Affleck-Ariz) W68-00738

TRACING PERCOLATION WATERS IN KARST AREAS, D. P. Drew

Trans Cave Res Group of Great Britain, Symp on Cave Hydrol and Water - Tracing, Vol 10, No 2, pp 107-114, May 1968. 8 p, 4 fig, 8 ref, disc.

Descriptors: *Tracers, *Indicators, *Dye releases, *Caves, *Infiltration, *Percolation, Movement, Tracking techniques, Currents (Water), Water circulation, Karst, Sampling, Spectrophotometry. Identifiers: *Water circulation tracing, Cave waters, Pryanine

The technique of tracing percolation water in karsts in Carboniferous limestone and Jurassic oolites using the fluorescent dye Pyranine conc. is described. The dye passes through the soil cover without being adsorbed. Sampling is accomplished by adsorption of the dye on activated charcoal suspended in bags. The dye can be detected visually using this technique at dilutions of 0.0000001, and at 1/10 that strength with ultraviolet light. Spectrophotometric determination may be used. Pryanine conc. shows adsorption maxima at 310 and 452 millimicrons. Field tests in England were successful; dye scattered on the surface showed up in springs several days to several weeks later. (Knapp-USGS) W68-00825

INVESTIGATIONS OF THE HYDROLOGY OF THE ROOT ZONE,

Clemson Univ., Clemson, S. C. James T. Ligon, Jerry R. Lambert, and Riaz

Report No 7, Water Resources Research Institute, Clemson University, Clemson, S C, July 1968. 109 p, 34 fig, 9 tab, 44 ref.

Descriptors: *Root zone, *Infiltration, Unsaturated flow, Diffusivity, Hydraulic conductivity, Numerical analysis, *Gamma rays, *Soil moisture, Evapotranspiration, Deep seepage, Soil density

The first part of this report deals with a study of infiltration into layered soils. A finite difference solu-tion of the unsaturated flow equation was used. Two field sites were selected and the profile characteristics, including h vs theta and D vs theta relationships, were determined. Theoretical infil-tration curves were computed for several initial moisture conditions. Experimental infiltration curves were obtained for comparison. Theoretical and experimental curves compared reasonably well except during early portions of the infiltration runs The second part of the report concerns a study of the gamma-ray transmission technique for field measurement of soil moisture. Techniques of field operation were developed to minimize errors due to electronic drift and temperature sensitivity of the equipment. Theory was developed for the determination of soil moisture changes without knowledge of soil density. Data relating to the precision of field measurements and the use of field capacity as a reference point were presented along with data showing the amount and distribution of soil moisture changes due to infiltration, drainage and evapotranspiration. (Author)

PIEZOMETER FOR MONITORING RAPIDLY CHANGING PORE PRESSURES IN SATURATED CLAYS,

U S Geological Survey For primary bibliographic entry see Field 07B. For abstract, see W68-00965

A SENSOR FOR WATER FLUX IN SOIL, (PART) 2--'LINE SOURCE' INSTRUMENT, Australia, CSIRO, and Australian National Univ, Canberra

For primary bibliographic entry see Field 07B. For abstract, see W68-00969

WATER-PHYSICAL PROPERTIES OF THE

WALER-PHYSICAL PROPERTIES OF THE EUPHRATES VALLEY SOILS,
Giprovodkhoz Minmeliovodkhoza SSSR.
I. S. Zoon, and N. S. Limachev.
Soviet Soil Sci, Vol 8, pp 1080-1092, August 1967.

13 p, 1 fig, 8 tab.

Descriptors: *Water properties, *Soil physical properties, Soil texture, *Irrigated land, Groundwater, Grasslands, Soil profiles, Soil stability, Permeability, Capillary action, Salts, Mineralogy, Soil horizons, Arid lands, Soil analysis, Field capacity, Moisture content, *Particle size, Porosity, Moisture content, *Particle size, Porosity, Leaching, Drainage systems. Identifiers: Euphrates Valley, Water physical properties, Ring method, Solonchaks, Slots, Iraq, In-

take rate, Swelling.

Water-physical characteristics of soils were determined by the ring method on 10 plots representing the main subgroup of Alluvial-Meadow and Solonchaks soils in the southern region of the alluvial plain formed by the Tigris and Euphrates Rivers. Alluvial-Meadow irrigated soils were formed under conditions of constant excess groundwater with a grassy, 'meadowy' vegetation. Fine texture, marked compactness throughout the profile, and indistinct nonwater-stable structure. profile, and indistinct nonwater-stable structure, which quickly disintegrates upon irrigation, were responsible for the low water permeability of the soils. The water-physical properties of periodically

inundated Alluvial-Meadow soil were studied on two plots down to the depth of 214 cm. Both soils had a high-lying capillary fringe which, in the case of strongly mineralized groundwater, resulted in the accumulation of salts in the top horizons. They were characterized by swelling, settling and un-satisfactory aeration with a moisture content equal to the field moisture capacity. (Blecker-Ariz.) W68-00998

EFFECT OF SURFACE-APPLIED WHEAT STRAW ON SOIL WATER LOSSES BY SOLAR DISTILLATION,

US Dept of Agriculture, Akron, Colorado For primary bibliographic entry see Field 03F. For abstract, see . W68-01004

INFILTRATION AND PERCOLATION STUDIES OF SULFIDES AND SEWAGE CARBONACEOUS MATTER,

Hawaii Univ, Honolulu. James S. Kumagai.

Water Resour Res Center, Univ Hawaii Techn Rep 7, June 1967. 58 p, 14 fig, 25 tab, 26 ref, append.

Descriptors: Sewage disposal, Organic loading, *Biodegradation, Soil disposal fields, Cesspools, Septic tanks, Sulfates, Sulfides, Percolating water, Infiltration, Groundwater movement.

The laboratory study of infiltration and percolation of sulfides and sewage carbonaceous matter was conducted in 2 phases: Phase 1 utilized simulated cesspool lysimeters and Phase 2 considered the generation of sulfides and the infiltration and percolation of sulfides through soil and sand columns. Phase 1 results dictated a need for further study owing to free percolation of certain odorous com-pounds and excellent COD removals under presumably anaerobic conditions contrary to find-ing in similar studies. In Phase 2 soil column was more effective for sulfide removal than the sand column which allowed continuous breakthrough of an odorous percolate. Progressive movement of a black precipitate through the sandbed indicated that filtering action of sand was not as effective as soil column. Under acid conditions, sulfide breakthrough was clearly demonstrated in both sand and soil columns. Flow rate significantly improved in both columns after percolation of acidified fluids. All columns exhibited charac-teristic nonlinear relationship between filtration and percolation rates and the hydraulic gradient. W68-01010

2H. Lakes

THE POST-GLACIAL DEVELOPMENT OF GRANE LANGSO,

K. Hansen Meddr Bansk Geol Foren, Vol 15, pp 446-458, 1965. 13 p, 6 tab, 8 fig, 15 ref.

Descriptors: *Eutrophication, Animal populations, *Plant populations, Bibliographies, Chemical analysis, *Systematics, Winds, Diatoms, Dissolved solids, Geologic history, *Glacial lakes, Bottom sediments, Logging (Recording), Light penetra-tion, Oligotrophy, Turbidity, Photosynthesis, Zooplankton, Plankton, *Paleolimnology, Sand

Identifiers: Mesotrophy, Denmark, Organic muds.

The author concludes from studies of borings made into the bottom sediments of Lake Grane Langso that, since the last glaciation, the lake has ranged from oligotrophy to eutrophy and is now back to oligotrophy. The lake, in Jutland, Denmark, is about 600 m long and an average of 200 m wide: the basin margins are steeper than the central part. Lobelia and Litorella occur to a depth of 3 m; Isoetes to 3-4 m; from 8 m to the deepest part (11.1 m), the bottom is covered by Fontinalis, Drepanocladus, and Nitella. The bottom from 5-7 m is nearly free of vegetation. Phytoplankton production is very small. There are few species in the zooplankton and only 13 animals/1 of water; the beach fauna is a rich one, and crayfish are particularly numerous. 10 bore holes indicate that sands are the deepest sediments, silt next higher. then an increasing admixture of organic material. and the uppermost layers are largely gyttja (organic material, and the uppermost layers are largely gyttja (organic mud). Beach sediments are blown into the lake by spring winds. The times of eutrophy correlate with 2 arid pollenzones, and those of oligotrophy with 2 humid pollenzones. humid pollenzones, as these waters are today. (Byrne-Wisc) W68-00678

THE RELATION BETWEEN SULFUR AND CARBON IN SEDIMENTS FROM THE EN-GLISH LAKES,

Toronto U., Canada.

E. Gorham

J Sed Petrol, Vol 30, No 3, pp 466-470, Sep 1960. 5 p, 4 tab, 11 ref.

Descriptors: *Eutrophication, Chemical analysis, Seasonal, Chemical reactions, Profundal zone, *Lakes, *Carbon, *Sulfur, Manganese, Iron, Bibliographies, On-site data collections, Reduction (Chemical), *Bottom sediments, Redox potentials, Clays, Fertility, Oxidation.
Identifiers: *English lakes.

Studies were made of 5 lakes in the English lake district: Wastwater and Ennerdale Water are unproductive deep lakes, Windermere is a deep lake of moderate productivity, Esthwaite Water is a shallow productive lake, and Priest Pot is a very productive pond. Lime and potash contents increase, as determined from samples collected from the uppermost 5-10 cm of bottom sediments, in the sequence in which the lakes are listed to a maximum concentration in the waters of Priest Pot. The carbon/sulfur ratio is higher in the oxidizing muds than in the reducing muds. The surface layer of Windermere mud was found to be continually oxidizing while that in Esthwaite Water became a reducing mud each summer. Sulfate sulfur may precipitate as sulfide from the lake water into mud when the redox potential is low; it is reduced and precipitated as sulfide in the mud. Carbon and sulfur are more abundant in the sediments of produc-tive lakes than in those of infertile nonproductive lakes, although the carbon/sulfur ratios are much higher in the latter. The low carbon/sulfur ratios in the productive lakes are related to their reducing intensity, which increases the total sulfur fixation. Esthwaite Water showed maximum percentages of carbon in a zone just above the glacial clay, indicating a more productive earlier stage. (Byrne-Wisc) W68-00679

EUTROPHICATION OF LAKES BY DOMESTIC

For primary bibliographic entry see Field 05C. For abstract, see W68-00680

PALEOLIMNOLOGICAL STUDY ON ANCIENT LAKE SEDIMENTS IN JAPA!

Otsu Hydrobiological Station, Otsu, Japan.

S. Horie

erh Int Ver Limnol, Part I, Vol 16, pp 274-281, 1966.

Descriptors: *Eutrophication, *Paleolimnology, Lakes, *Water level fluctuations, Japan, Geologic history, Coring, Bottom sediments, Peat, Lake morphometry, Sedimentation rates, Lake level fluctuations, Nitrogen, Pleistocene epoch. Identifiers: *Climatic cycles.

The author made studies of the bottom sediments of three (3) lakes in Japan and concluded from them that changes in trophic levels of the lake were brought about by fluctuations in lake levels and by climatic changes. The three (3) lakes studied ranged in area from 1.4 sq km to 14.5 sq km, and in maximum depths from 7.0 m to 29.5 m. The most

extensive lake (Lake Suwa-ko), but the shallowest, was found to have bottom sediments 400 m thick; evidence indicates that this lake is about 3,000 years old, but that its rate of sedimentation was very rapid; core samples indicate that the sediment fill is largely peat. The smallest and the deepest of the lakes (Lake Kizaki-ko) is apparently the oldest of them all, an estimated age of 30,000 years, and an annual rate of sedimentation of about 0.2 mm. The third lake (Yogo-ko) is judged by the author to have undergone a sharp drop in level, thus leading to its rapid eutrophication. (Byrne-Wisc) W68-00681

AN EXPERIMENT IN THE ARTIFICIAL CIR-

CULATION OF A SMALL MICHIGAN LAKE, Michigan Dept Cons, Div Cons, Michigan State College; Colorado Coop Fish Res Unit, Colorado A and M College.

Frank F. Hooper, Robert C. Ball, and Howard A. Tanner

Trans Amer Fish Soc, Vol 82, pp 222-241, 1952.

20 p, 8 fig, 2 tab.

Descriptors: *Eutrophication, Epilimnion, Thermocline, Water temperature, Conductivity, *Water properties, Alkalinity, Hypominis Conductivity, *Water Dissolved *Lakes, Dissolved oxygen, Phosphorus, Phytoplankton, Periphyton, Turnovers, Michigan, Phosphorus, On-site data collections, Bibliographies, Limnology, *Pumping.

The authors found that the pumping of the waters of a lake induced an overturning like that of the fall circulation. A centrifugal pump was used to bring waters from the hypolimnion to the epilimnion in a small trout lake in Michigan. 20.7% of the volume of water in the lake was displaced during the test period, as the result of which, the volume of the epilimnion was increased by 49.9%, the hypolimnion was decreased in volume accordingly, and the thermocline was lowered steadily. No significant change in water temperature was observed during, nor in the period immediately following, the pumping. Conductivity and alkalinity increased in both zones during the pumping period, and dissolved oxygen increased rapidly in the bottom water. The total phosphorus in the epilimnion increased during the first 48 hours of pumping but decreased the reafter to the pre-pumping level; the ultimate addition was only a small one. The volume of phytoplankton in the epilimnion increased by 8-10 times during the period of pumping; it remained high for the three weeks following conclusion of the experiment. The growth of periphyton also in-creased during the pumping period. (Byrne-Wisc) W68-00682

GREAT LAKES LIMNOLOGICAL INVESTIGA-

For primary bibliographic entry see Field 05C. For abstract, see W68-00683

RECENT CHANGES IN THE TROPHIC NA-TURE OF LAKE WASHINGTON--A REVIEW, For primary bibliographic entry see Field 05C. For abstract, see W68-00684

RESPONSES OF A MARL LAKE TO FER-

TILIZATION, Inst Fish Res, Michigan Dept Cons, and Dept Fish and Wildlife, Michigan State University. For primary bibliographic entry see Field 05C. For abstract, see W68-00685

PRIMARY PRODUCTIVITY AND LIMITING FACTORS IN THREE LAKES OF THE ALASKA PENINSULA,

Dept. of Fish, University of Michigan. C. R. Goldman. Ecol Monogr, Vol 30, pp 207-230, 1960. 24 p, 14

Bibliographies, Descriptors: *Eutrophication, *Lakes, Carbon radioisotopes, Photosynthesis, Salmon, *Limiting factors, Phytoplankton, *Aquatic populations, Zooplankton, On-site data collections, Alaska, Glacial lakes, Igneous rocks, Seasonal, Chemical properties, Bottom sediments, Nutrient requirements

In Brooks Lake, Alaska, primary productivity appears to correlate with variations in total phytoplankton which, in turn, correlates with the seasonal decline in light energy; the zooplankton exhibit the same correlation. The author studied three large lakes (Brooks, Naknek, Becharof) near the base of the Alaska peninsula for the purpose of measuring and comparing the primary productivity of red salmon nurseries, and to determine the limiting factors. The carbon-14 technique was used in the bioassay of nutrient limiting factors and the direct measurement of primary productivity. The author reports in detail the data obtained for each of the three lakes. Magnesium was found to limit phytoplankton production during the summer; its importance diminishes toward major tributaries where other nutrients become more important as limiting factors. Nitrate deficiency was evident in all lakes during July and August. Phosphorus was not as critical a factor in photosynthesis as magnesium sulphate or calcium nitrate until middle August. Bottom sediment extract was judged to be very stimulating to the natural phytoplankton of Brooks Lake. (Byrne-Wisc) W68-00686

ENVIRONMENTAL CHANGES IN LAKE ERIE,

For primary bibliographic entry see Field 05C For abstract, see

THE INFLUENCE OF INTRASECULAR VARIA-TIONS OF WETNESS OF LAKE BASINS UPON THE DEVELOPMENT OF THEIR DEPRES-SIONS,

Leningrad Univ., USSR, Lake Research Laborato-

A. V. Shnitnikov

Bull Int Ass Sci Hydrol, Vol 13, No 2, pp 92-107, June 1968. 16 pp, 11 fig, 3 tab, 12 ref.

Descriptors: *Lakes, *Lake basins, *Playas, *Semiarid climates, Inflow, Geomorphology, Lake beds, Lake morphology, Lake soils, Lake stages, Water levels, Climates, Meteorological data, Regional analysis, Droughts, Synoptic analysis, Water level fluctuations.

Identifiers: *Semiarid zone lakes, Lake-level fluctuations, Lake desiccation, Deflation (Wind), Climate fluctuation, Wetness index.

The development of lakes in the semiarid parts of western Asia in the USSR is studied in relation to climatic cyclic fluctuation. The area studied is so large that variations in the general wetness are not perfectly synchronous throughout, although the climate is characterized by large regional wetness mate is characterized by large regional weitless fluctuations. Lakes are fed either by mountain runoff or by runoff from the plains. The duration of periods of rise and fall of plains lakes is shorter than those of the mountain-fed lakes. Plains lakes have periods of water-level fluctuation that last from 29 to 47 yr with a shorter cycle of 7-11 yr superimposed. In wet periods the lakes receive silt and tend to fill; in dry periods, many dry out and silt is removed by deflation. Dry periods are generally longer than wet ones, so the basins of lakes that usually dry out in droughts tend to enlarge by deflation. Since salt carried out of dry lakes during deflation is deposited on the land surface, soils tend to be saline for miles around lakes. Deflation affects only the margins of lakes that do not completely dry, so that their wet parts tend to fill up while their basins become wider and shallower, resulting finally in large dry flats. Periodic drying and wetting also contribute to the production and storage in lake basins of organic material. (Knapp-USGS)

W68-00842

Group 2H-Lakes

ACCELERATED FACTORS AFFECTING ACCEPTAGE EUTROPHICATION OF FLORIDA LAKES, **AFFECTING**

Florida Univ., Gainesville, Florida Resources Research Center.

Hugh D. Putnam.

Office of Water Resources Research, Project Completion Report A-002-FLA, August 1968. 123 pp, 36 fig, 28 tab, 37 ref.

Descriptors: *Eutrophication, Algal blooms, Water bloom, Aquatic algae, Aging (Brological), *Aquatic productivity, Limnology, *Nutrients, Bio mass, Oligotrophy, *Primary productivity, Tropic level, Water quality, Waste assimilative capacity, Standing crop, Annual turnover, Fish populations.

Eutrophication has been investigated in an experimental lake under stress with a predetermined nutrient loading rate (500 mg N and 42.7 mg P/M 3 yr). Objectives are to determine valid parameters in assessing trophic levels in shallow, subtropical lakes and to develop new criteria if necessary; to construct a mathematical model of eutrophication using systems analyses; and to identify controlling factors in eutrophication. Thus far the experimental lake has phosphorus and ammonia nitrogen in excess of levels in an adjacent control lake, but no clear cut biological differences between the two lakes have been noted. Primary production and plankton chlorophyll have remained low (1 - 190 mgC per M 3 day - 1, 1 - 18 mg Chl a/m 3). Bioassays for limiting nutrients reveal that phosphorus commonly limits production in the experimental lake while many nutrients (phosphorus, trace metals, vitamins, silica) have cyclic behaviors in the control lake. The microbiota of the lake is varied, but a measurable crop of Dinobryon, Synura, Peridinium umbonatum and Stentor amethystinum persists at times. Tertiary trophic levels are being investigated using the planktivorous fish Labidesthes sicculus. Changes in zooplankton biomass and the Labidesthes population are being monitored. (Author) W68-00912

THE MICRODISTRIBUTION OF STREAM BENTHOS,

Pittsburgh Univ., Pittsburgh. Kenneth W. Cummins.

Progress Report, Dept. Interior, Federal Water Pollution Control Administration. Aug. 1968. 43 pp, 3 fig, 17 tabels, 39 references; 131 pp of Appendi-

Descriptors: *Food habits, Food webs, *Benthos, *Secondary productivity, *Detritus, Aquatic animals, Computer programs, Lotic environment, Streams, Energy transfer, Energy budget, Fish food organisms, Ecological distributions, *Caddisflies, *Midges, Mayflies, Diatoms, Sculpins, Crayfish, Stoneflies, Water beetles, Oligochaetes, Diptera. Identifiers: Secondary productivity, *Benthos tropic relations, Aquatic insects, Lotic environment, *Energy budget, Ecosystems.

A causal relationship is indicated between tropic structure and stream community stability, namely a dependence on constant precentages of biomass (energy) being processed by three trophic categories: herbivores, detritivores and carnivores. The relationship is not clear unless data are gathered and manipulated on the basis of tissue support, i. e. calories of organisms supported by calories of living plant tissue intake, etc. The consistency of microdistribution patterns of benethic species is also closely dependent upon the tropic structure. Present research is aimed at demonstrating the manipulative ranges possible within the theoretical framework of the tissue-support, trophic basis of stream stability. A stable (according to the above trophic stability criteria), semi-natural system will the employed to establish upper and lower limits to the stability pattern by manipulating relative amounts of energy carried by each of the 3 'trophic channels'. (Author) W68-00914

RECENT STUDIES ON THE ROLE OF MICROORGANISMS IN THE CYCLING OF SUBSTANCES IN LAKES.

Academy of Science of USSR, Inst. of Microbiology, Moscow.

For primary bibliographic entry see Field 05C. For abstract, see. W68-00946

CHARACTERIZATION OF PHOTOSYNTHETIC

CHARACTERIZATION OF PHOTOSYNTHETIC SULFUR BACTERIA CAUSING RED WATER IN LAKE FARO (MESSINA, SICILY), Woods Hole Oceanogr Inst, Woods Hole, Mass, and Inst di Idrobiologia e Pescicoltura, Messina,

Hans G. Truper, and Sebastiano Genovese. Limnol and Oceanogr, Vol 13, No 2, pp 225-232, April 1968. 8 p, 3 fig, 3 tab, 37 ref.

*Sulfur bacteria, *Red Descriptors: *Photosynthetic bacteria, Interfaces, Ecological distribution, Environmental effects, Lakes. Identifiers: *Lake Faro, Italy, Chlorobacteriaceae, Thiorholaceae, Red water.

Isolation of photosynthetic sulfur bacteria was made to help characterize the causative agent of the red water layer in Lake Faro. This meromictic saline lake contains a layer of brownish-red water at the interface between hypo- and epilimnion, the depth of which varies between 8-13 m. The predominant organism of the red water is the brown photolithotropic bacterium Chlorobium phaeobacteroides Pfennig (Chlorobacteriaceae). In addition, a small, violet Chromatium species (Thiorhodaceae), which had been observed in smaller numbers in the red layer, was isolated. Although the Chromatium strain is motile and able to use a considerable variety of organic carbon compounds besides bicarbonate, in the natural environment of the lake the brown Chlorobium finds more advantageous growth conditions; it is suggested that its brown carotenoids allow more effective use of the penetrating wavelengths of daylight. (Llaverias-USGS) W 68-00950

BACTERIAL CAROTENOIDS FROM FRESH-

WATER SEDIMENTS, Queen's University, Kingston, Ontario, Department of Biology. Seward R. Brown

Limnol and Oceanogr, Vol 13, No 2, pp 233-241, April 1968. 9 p, 3 fig, 3 tab, 26 ref.

Descriptors: *Sediments, *Aquatic bacteria, *Lakes, *Mud-water interfaces, Environmental ef-

Identifiers: *Bacterial carotenoids, Spheroidenone, Spheroidene.

Details are reported on the extraction and isolation of carotenoids from sediment cores in Little Round Lake, Ontario. Carotenoids are identified by comparison with authentic specimens from Rhodopseudomonas. Crystalline preparations of spheroidenone were obtained from extracts of the sediment, together with smaller quantities of spheroidene (pigment Y) and 2-ketospirilloxanthin (P-518). The bacterial carotenoids occur in association with algal carotenoids, chlorophyll derivatives, and bacteriopheophytin. Cis-trans isomerization of the compounds appears to have taken place in the sediments. Three stereoisomers of spheroidenone and 2 of spheroidene were found. P-518 was isolated only in the trans form. The isomerization process may have geochemical implications. No morphologically distinguishable remains of the organisms that produced the pigments could be found in the sediments. The relative proportions of the 3 fossil xanthophylls are in close agreement with those found in senescent cultures of Rhodopseudomonas spheroides when grown under aerobic conditions. (Llaverias-USGS) W68-00951

TEMPERATURE AND CURRENT OBSERVATIONS IN CRATER LAKE, OREGON,

Oregon State Univ., Corvallis. Dept. of Fisherie and Wildlife.

H. V. Kibby, J. R. Donaldson, and C. E. Bond. Limnol and Oceanogr, Vol 13, No 2, pp 363-366 April 1968. 3 p, 3 fig, 7 ref.

Descriptors: *Water temperature, *Measurement *Currents (Water), Profiles, Oregon. Identifiers: *Crater Lake, Thermistor, Heat in

Vertical and horizontal temperature profiles wer made and drift devices released to contribute to th knowledge of the physical features of Crater Lake An electrical resistance thermistor was used t measure temperature from the surface to 150 m a Il o sampling stations. A thermistor probe took tem perature readings at 1-min intervals at 5 crossings 4-liter polyethylene floats were used to study cur rents. Temperature data from the thermal profile of maximum thermal development in the lake wer used to calculate a summer heat income of 30,01 cal/sq cm. The maximum surface temperatur recorded was 18.8C at a point 100 m northeast of Pumice Point and 10 m from shore. General sur face currents show a counterclockwise sycloni movement along the shoreline; an isotherm plot in dicates temperature differences across the lake sur face. Minimum water movement occurred in Cleel wood Cove; currents from midlake appeared to ter minate in the cove. This supports a common belie that anything lost on the lake will float into Clee wood Cove. (Llaverias-USGS) W68-00954

2I. Water in Plants

EFFECTS OF SEASONAL VARIATION II RADIATION AND TEMPERATURE ON NE ASSEMILATION AND GROWTH RATES IN A ARID CLIMATE

Australia, CSIRO, Division of Plant Industry, Car

J. Warren Wilson.

Ann of Botany, N.S., Vol 31, No 121, pp 41-57, Ja 1967. 17 p, 10 fig, 4 tab, 27 ref.

Descriptors: *Temperature, *Growth rates, *Ari climates, *Plant growth, *Solar radiation, Leave Regression analysis, Variability, Seasona Meteorological data, Analytical techniques, Diur nal, Humidity, Envi Photosynthesis, Biorhythms. Environmental effect Identifiers: *Assimilation rates, *Leaf-area ration New South Wales, Australia.

The study examined the effects of radiation an temperature on the growth of rape, sunflower an temperature on the growth of rape, sunflower an maize at various times of the year in the arid cl mate at Deniliquin, New South Wales. The net as similation rate, relative growth-rate, and leaf-are ratio were measured. Temperature range did no appear as a significant variable except in interaction with radiation and with mean temperature Multiple regression, analysis showed the net as Multiple regression analysis showed the net as similation rate to rise with radiation. For all thre species, the relative growth rate showed a tendenc to increase with both temperature and radiation The leaf-weight ratio tended to increase with radia tion in both rape and sunflower. Sunflower, showe the rise in specific leaf area with falling radiation but the response to temperature was not significant. Most of the variation in net assimilation rat and relative growth rate was accounted for in term of radiation and temperature. (Blecker-Ariz)

SEED GERMINATION AND ESTABLISHMEN' AS AFFECTED BY NON-WETTABLE SOIL AND WETTING AGENTS, University of California, U. S. Department of Agriculture, Forest Service, Pacific Southwes Forest and Range Experiment Station. J. Osborn, J. Letey, and L. F. DeBano. Ecology, Vol 48, No 3, pp 494-497, 1967. 4 p,

Descriptors: *Germination, *Surfactants, *Vegetation establishment, *Seeds, *Wettability, Soil water movement, Slopes, Impervious soils, Toxicity, Irrigation, Plant growth, Grasses, Nitrogen, Erosion control, Soil texture, Heating, Wetting, Slope stability.

Identifiers: Non-wettable soils.

The purpose of the study was to make an analysis of the effect of soil wettability and treatment with wetting agents on seed germination and plant establishment. A naturally occurring non-wettable sandy loam soil was used. The plant species studied were wimmera ryegrass, black mustare and intermediate wheatgrass. The seeds were placed on the level and on a 30 degree slope. It was concluded that the soil material did not possess toxic substances which would prevent germination since all seeds irrigated with the untreated soil extracts ger-minated. Treatment affected seed germination on non-wettable soil. The difference between the untreated and wetting-agent-treated non-wettable soil placed on the slope was very great. Top growth was generally less on wettable than non-wettable soil, perhaps indicating a loss of nitrogen when the soil was heated to make it wettable. (Blecker-Ariz) W68-00698

GRASS ESTABLISHMENT UNDER SEMI-ARID CONDITIONS IN CENTRAL TANGANYIKA,

Tanzania, Ministry of Agriculture, Forest and Wildlife, Pasture Research Station; Australia, CSIRO,

diffe, Pasture Research Station, Australia, CSIRO, Div. of Entomology, Canberra.
M. A. Owens, and H. W. Brzostowski.
Tropical Agr (Trinidad), Vol 44, No 4, pp 275-291, Oct 1967. 17 p, 10 tab.

Descriptors: *Grasses, Seed treatment, Semiarid climates, *Rainfall, Drilling, Dry seasons, *Planting management, *Seeds, Wet seasons, Soil-water-plant relationships, Soil moisture, Fertilizers, Weed control, *Vegetation establishment, Germination, Crop response.

Identifiers: Perennial grass, Plots, Tanganyika

Cenchrus ciliaris L. has been the grass most widely used at Kongwa in establishment work. Rainfall, averaging just over 21 inches per year, can be very erratic. It is confined almost entirely to a four month period extending from mid-December to mid-April. From the aspects of both evenness of distribution and seed economy, drilling has been more satisfactory than broadcasting. From strip planting observations it seemed that the most valuable perennial grass species employed were incapable of satisfactory natural spreading. The pelleting of seed adversely affected germination in laboratory tests while in the field trial, more than three times as many C. ciliaris plants were counted on plots where unpelleted seed was sown than where ties of sowing C. ciliaris in the dry season, a very satisfactory establishment was obtained in two years out of three when seed was sown about two months before the onset of rains. (Blecker-Ariz) W68-00701 pelleted seed was used. In exploring the possibili-

HIGH NET ASSIMILATION RATES OF SUN-FLOWER PLANTS IN AN ARID CLIMATE, Australia, CSIRO, Division of Plant Industry, Can-

J. Warren Wilson. Ann of Botany, N S Vol 30, No 120, pp 745-751, Oct 1966. 7 p, 1 fig, 3 tab, 24 ref.

Descriptors: Plants, *Arid climates, *Environmental effects, Root development, *Photosynthesis, Climatic zones, Fertility, *Plant growth, Leaves, Speciation, Nutrients, Harvesting, *Gases chromatology, Radiation.

Identifiers: *Assimilation, *Dry matter, Gas-analytic *Supplements

sis, *Sunflowers

The rate of increase of dry matter per unit leaf area (net assimilation rate, E) varies with species and environment. Sunflower plants were grown in rooting mediums of soil and nutrient culture. The studies on the plant's growth at Deniliquin, New South

Wales, indicated maximum values of E near 2.0 grams of dry matter to the minus two power, week to the minus one power. The values of E exceeded by a large margin all values of E previously recorded for the sunflower or any other species in any part of the world. The high E values were attributed to the climate. Both dry-matter harvesting and gas-analysis indicated that plants of certain species grown in fertile soils could achieve, in arid climates, rates of assimilation roughly double those hitherto regarded as maximal. (Blecker-Ariz) W68-00710

RESPONSES OF GRASSES SEEDED IN AN AR-TRIDENTATA HABITAT IN TEMISIA NEVADA,

Nevada Univ., Reno, Div. of Plant Science; U. S. Department of Agr., Agr. Research Service, Crops Res. Div., Reno, Nevada and Logan, Utah. J. H. Robertson, Richard E. Eckert, Jr., and A. T.

Ecology, Vol 47, No 2, pp 187-194, 1966. 8 p, 2 fig, 3 tab.

Descriptors: *Sagebrush, *Competition, Vegetation establishment, Crop response, *Environmental effects, *Vegetation effects, *Grasses, Precipitation (Atmospheric), Invasion, Shrubs, Crop production, Plant populations, Fluctuation, production, Pla Seasonal, Annual.

Identifiers: Perennial grasses, Adaptation, Survival,

The study was initiated in north-central Nevada in 1943 to learn some of the effects of big sagebrush upon 17 perennial grasses. Three intensities of shrub competition were established: intense, reduced and no competition. Results were expressed in terms of survival, yield and spread of seeded species, and degree of invasion by big sagebrush and cheatgrass. Native bunchgrasses as a group, without regard to intensity of competition, were relatively poor compared to Agropyron desertorum. As a group the sod-forming species per-formed better than the bunchgrasses. Herbage yields reflected relative adaptation to the site and to seasonal and yearly fluctuations in factors of the habitat. Good herbage production and vagetative spread of the sod-forming agropyrons under brush competition and fluctuating precipitation indicated the aggressiveness and competitive ability of the species. Invasion by the winter annual Bromus tectorum was an indication of relative success of treatments to establish perennial grasses and of perennial grasses to dominate the plot area through competition for limiting environmental factors. (Blecker-Ariz) W68-00712

THE PRACTICAL APPLICATION OF AERIAL PHOTOGRAPHY FOR ECOLOGICAL SURVEYS IN THE SAVANNAH REGIONS OF

Hunting Technical Services, Ltd., Boreham Wood, Herts (Great Britain).

G. E. Wickens.

Photogrammetria, Vol 21, No 2, pp 33-41, April 1966. 9 p, 3 fig, 1 append.

Descriptors: *Aerial photography, *Ecological distribution, Soil survey, *Biological communities, Vegetations, Topography, Soils. Identifiers: Africa.

Ecological surveys are complementary to a soil survey in that they can provide additional information on conditions at the time of the survey. The ecological survey should either precede or coincide with the soil survey. The four stages of the survey are given and discussed. For primary communities there is usually a strong correlation between the vegetation, topography and the soil. The plotting of boundaries of plant communities is based on the identification of the constituent species, which, presupposing good photography, is related to the scale. Since the time of photography is important, the latest photography available should be used,

provided it has been taken at the correct time of year. (Blecker-Ariz) W68-00727

CHROMOSOME VARIATION IN ECOTYPES OF LARREA DIVARICATA IN THE NORTH AMERICAN DESERT,

Texas Univ., Austin; Arizona Univ., Tucson. Tien Wei Yang, and Charles H. Lowe. Madrono, Vol 19, No 5, pp 161-164, April 1968. 4 p, 1 fig, 1 tab.

Descriptors: *Variability, *Chromosomes, *Plant populations, Plant morphology, Ecology, Environmental effects, Acclimatization, Plant physiology, Precipitation intensity, Correlation analysis, Ecotypes, Resistance, Genetics. Identifiers: *Creosotebush, Sonoran Desert,

Chihuahuan Desert, Adaptation.

A review of reports on the chromosome variation in populations of creosotebush, (Larrea divaricata) in the Chihuahuan and Sonoran deserts showed the correlation between environment and species adaptation. The western variety of the Sonoran Desert had a chromosome number of 2n=52 and the eastern Chihuahuan variety had a number of 2n=26. Thirteen populations studied in a transect 2n=20. Inirteen populations studied in a transect which traversed the Chihuahuan and Sonoran Desert longitudinally showed wide variation in chromosome number. The morphologic and physiologic differences between the eastern and western variety reflected the diverse climatic regimes under which they evolved. The Chihuahuan variety has been subjected to greater precipitation and lower temperatures while the precipitation and lower temperatures while the Sonoran ecotype was subjected to lower precipitation and higher winter temperatures. (Affleck-W 68-00732

RECENT POLLEN DEPOSITION IN MILLER'S

BAY, LAKE OKOBOJI, IOWA, Iowa State Univ., Ames, Dept. of Botany and Plant

Pathology. Ruth M. Webster, and John D. Dodd. Iowa Acad. Sci. Proc., Vol. 72, pp.73-83, 1965.

Descriptors: *Lake bottom sediments, *Pollen distribution patterns.

Identifiers: Proportional pollen counts, Lake Okoboji, Iowa, Pollen in algal mats, Basswood pol-

Nine samples of surface sediments from a settling basin were treated with hydrofluoric acid, Schultze's reagent, and ammonium hydroxide and then stained with Safranin. Proportional pollen counts of 200 per sample were made and the range of occurrence of 22 pollen types in the nine samples was currence of 22 pollen types in the nine samples was determined. In order of decreasing abundance these are composites, oak, grass, pine, elm, spruce, hickory, basswood, walnut, Ostrya, ash, birch, willow, box elder, fern, hackberry, Myriophyllum, Sparganium, Typha, Alnus and Potamogeton. The period of dispersal for basswood pollen in 1964 was determined to be from lune 27 to but 144. determined to be from June 27 to July 14 near the study site. Pollen of 15 types was found to occur in floating algal mats collected in late June. These mats contained a high proportion of basswood pollen and much less oak and elm pollen than present in the sediments, indicating a development of the algal mats after the peak dispersal period for these pollens. (Dodd-Iowa St.) W68-00915

ASPECTS OF THE DROUGHT TOLERANCE IN CREOSOTEBUSH (LARREA DIVARICATA), Arizona Univ, Tucson; USDA, Agricultural Research Service, Crops Research Div., Tucson. R. E. Saunier, H. M. Hull, and J. H. Ehrenreich. Plant Physiol, Vol 43, No 3, pp 401-404, 1968. 4 p. 2 Tab, 28 ref.

Descriptors: Biochemistry, *Drought resistance, *Moisture stress, Leaves, *Amino acids, Chro-

Field 02-WATER CYCLE

Group 21-Water in Plants

matography, Chemical analysis, Wilting, Hydrolysis, Foliar, *Plant physiology, *Metabolism, Proteins, Soil-water-plant relationships, Degradation (Decomposition), Nitrogen, Translocation, Greenhouses, Laboratory tests. Identifiers: cycle,

Identifiers: Adaptation, Krebs
*Creosotebush, Chihuahuan Desert, *Sugars.

Biochemical adaptations to drought conditions were studied in Creosotebush (Larrea divaricata) collected in 3 localities in the Chihuahuan Desert. After a year's growth under greenhouse conditions 48 randomly selected plants were divided into 2 groups. One was subjected to water stress for 7 days and the other to optimum watered conditions. At the end of the treatment period the leaves were analyzed for amino acids, using a Beckman model B 120 amino acid analyzer and soluble sugars were determined using paper chromatography. In the stressed plants glucose and sucrose concentrations were reduced while fructose was not changed significantly. Amino acids were increased, especially proline and amino acids in the pyruvic acid families. Alanine and valine, which are synthesized from pyruvic acid may have had an NH3 storage function during wilting. This increase was attributed to protein hydrolysis and not translocation from roots. A relationship was suggested between drought tolerance and loss of soluble sugars (possibly increased Krebs cycle activity) and increased foliar accumulation (possibly synthesis) of amino acids. (Affleck-Ariz) W68-01005

2J. Erosion and Sedimentation

AUTOMATIC TEST OF SUSPENDED-SEDIMENT PUMPING SAMPLER, Department of Agriculture, Flagstaff, Arizona, Forest Service, Rocky Mountain Forest and Range Experiment Station. Edward Hansen.

Trans Amer Soc of Agr Eng, Vol 9, No 5, pp 739-743, 1966. 6 p, 10 fig.

Descriptors: *Electrical equipment, *Sediment transport, Discharge measurement, Intakes, *Sampling, *On-site tests, *Suspended load, Bed load, Sediment yield, Pumps, Streams, Seasonal, Runoff, Flow rates, Sands, Particle size, Intermittent streams

A suspended-sediment sampler was developed which automatically pumped a sample at predeter-mined time intervals from a point in the stream. The system was operated for one year on an ephemeral stream in Arizona. Three intakes were installed to increase chances of obtaining a good relationship between pump sample concentration and average concentration in the stream. From winter runoff data, it was determined that the lower intake had the better sampling efficiency. Concentrations from 14 summer flows ranged up to 51,400 ppm. Peak summer flow discharge was 600 cfs. During winter runoff an average of 55% of the sediment was of sand size with most samples containing 35-65% sand. There was less sand in summer samples than in winter samples. Median particle size of sediment during winter flow was about 0.07 mm whereas median size during summer flow was 0.01 mm. 70% of the pump sample concentrations during winter flow were within plus or minus 20% of the average concentrations of the channel. There was a trend of decreasing variability with increasing discharge. Variation of the summer flow increased with increasing discharge. (Blecker-Ariz)

SIMPLE SEDIMENT SAMPLER FOR FLUMES,

Department of Agriculture, La Crosse, Wisconsin, Forest Service, North Central Forest Experiment Station.

Richard S. Sartz, and Willie R. Curtis.
Agricultural Engineering, Vol 48, No 4, p 224,
April 1967. 1 p, 1 fig.

Descriptors: *Sediment discharge, *Flumes, *Sediment distribution, *Sampling, Suspended load, Dye releases, Instrumentation, Tracking techniques.

A simple automatic stage sampler, especially adapted for use with metal flumes, has been used with good results on both H- and San Dimas-type flumes. Flush piezometer taps were placed in the flume wall at different heights. Flexible tubing connects each tap to a 1-pint bottle sealed with a twohole stopper. Tests with a dye indicate that the horizontal distribution of suspended sediments are relatively even in the flume. (Blecker-Ariz) W68-00708

FIELD TEST OF AN X-RAY SEDIMENT-CON-

CENTRATION GAGE, U. S. Department of Agriculture, Agr. Research Service, Soil and Water Conservation Res. Div., Sedimentation Lab., Oxford, Mississippi. Carl E. Murphree, Gerald C. Bolton, and J. Roger

Amer Soc Civil Eng J, Vol 94, Proc Paper 5868, pp 515-528, March 1968. 14 p, 4 fig, 1 tab.

Descriptors: *X-ray analysis, Sediment distribu-tion, *Streams, On-site tests, *Sediment load, *Runoff, *Flow rates, *Gages, Suspended load, Streambeds, *Parametric hydrology, Calibrations, Logging (Recording), Stream gages. Identifiers: *Parametrics.

The parametrics sediment gage consists of a sensing unit which is installed in a stream and a recording unit situated on shore. Operation of the gage is based on measuring the ratios of the attenuation of X-rays through river water and through a reference cell containing distilled water. This ratio is a function of the concentration of suspended sediment in the river water. The gage is calibrated in the U.S. D.A. Sedimentation Laboratory prior to field installation. The gage was installed in Pigeon Roost Creek Watershed, Marshall County, Mississippi. Water flows continuously at a rate of 8-10 sec-ft with a mean solids concentration ranging from 5-20 ppm. During direct storm runoff, peak flow rates of 6720 sec-ft have been recorded with peak suspended sediment concentration of about 15,000 ppm. Experiences indicate that continuous reading of sediment concentration at one point is not necessarily, nor is it usually, a good measure of mean vertical or cross-sectional concentration. (Blecker-Ariz)

COASTAL SAND DUNES OF GUERRERO NEGRO, BAJA CALIFORNIA, MEXICO,

California University, Scripps Institution of Oceanography, La Jolla, California.
D. L. Inman, G. C. Ewing, and J. B. Corliss.
Geol Soc of Amer Bull, Vol 77, No 8, pp 787-802,
August 1966. 16 p, 7 fig, 5 tab, 23 ref.

Descriptors: Semiarid climates, *Aeolian soils, Sediment yield, Sand waves, *Dunes, *Velocity, *Movement, Wind velocity, Ripple marks, Coasts, Lagoons, Mexico, Tides, Beaches, Barriers, Water

table, Shear, Surges. Identifiers: Baja California, Barchans, Laminations.

Wind blown snad is filling many lagoons along the semi arid Pacific Coast of Baja California where effective precipitation is 25-30 cm. Above 30 cm. sediment yield decreases. The uniformly spaced, barchan-shaped dunes of about 6 meters high and 70 meters horizontal width are migrating inland with a sea breeze from the northwest at the rate of 18 meters per year. The uniformity in size and shape of the dunes as they traveled away from saltimpregnated sand was related to the floor of the dune field which was controlled by the water table. Measured distance of travel was about twice that calculated by the von Karman-Prandtl equation.
There was little difference in roundness between beach sand and that of the interior. A lamination of fine-grained dark minerals delineated the plane of shear between moving and residual sand. The bedding structures common to the dunes were:

avalanche bedding, ripple laminations and swash laminations. (Blecker-Ariz)

CORRELATIONS FOR SEDIMENT TRANSPORT IN FLUMES, Strathclyde Univ., Glasgow, Scotland.

John G. Herbertson.

Bull Int Ass Sci Hydrol, Vol 13, No 2, pp 5-19, June 1968. 15 pp, 11 fig, 14 ref.

Descriptors: *Flumes, *Sediment transport, *Sediment discharge, *Model studies, *Dimensional analysis, Hydraulic models, Analytical techniques, Theoretical analysis, Mathematical studies, Linear programming.
Identifiers: *Sediment transport flume studies,

*Non-dimensional functional equation.

A method of synthesis was used to combine the variables characterizing sediment transport in laboratory flumes into nondimensional functional equations which may be used as a basis for logical data correlations. By selecting appropriate nondimensional groups the effect of variation of individual variables can be determined. Experimental work must be performed carefully so that the variables held constant are carefully chosen and properly regulated. Otherwise, as with much of the published work in the field, it may not be possible to isolate and correlate the effects of the individual variables on each other. More data on low-density sediments are required to evaluate the usefulness of materials of various densities for bed load studies in sediment transport models. (Knapp-USGS) W68-00832

THE STANFORD SEDIMENT MODEL I: TRANSLATION. Strathclyde Univ., Glasgow, Scotland.

George Fleming. Bull Int Ass Sci Hydrol, Vol 13, No 2, pp 108-125, June 1968. 18 pp, 2 tab, 6 ref.

Descriptors: *Model studies, *Computer models, *Sediment transport, *Computer models, *Sediment transport, *Computer programs, *Digital computers, Runoff, Erosion, Sediment load, Bed load, Sediment discharge, Suspended load, Programming languages, River basins. Identifiers: *Computer program translation.

A sediment transport model for digital computer and a program translated into 1900 Algol, a programming system used in Europe, are described. The original model and program were developed by Negev at Stanford. Results from the use of the translated program have been checked against the original by running the same data for the Napa River in both; they are in complete agreement. The model considers the entire watershed and an attempt is made to simulate the erosion-deposition processes for the watershed by distinguishing between 2 main sources of sediment--the land surface and the stream system. The effects of splash erosion, overland flow, rill erosion, and gullies are added to the stream's wash load, interload, and bed load. (Knapp-USGS) W68-00834

TIME SERIES ANALYSIS OF WATER AND SEDIMENT DISCHARGES,

Colorado State Univ, Fort Collins, Colo, and U. S Geological Survey, Fort Collins, Colo. Ignacio Rodriquez-Iturbe, and Carl F. Nordin. Bull Int Ass Sci Hydrol, Vol 13, No 2, pp 69-84, June 1968, 16 pp, 12 fig, 2 tab, 10 ref.

*Sediment load, processes, *Time series analysis, *Frequency analysis, *Correlation analysis, Suspended load, Discharge (Water), Statistical methods, Mathematical models, Fourier analysis. Identifiers: *Cross-spectral analysis, Spectral anal-

The techniques of time-series analysis were applied to long-term water and sediment discharges meato long-term water and sediment discharges measured at 4 stations on the Rio Grande between Otowi, and San Marcial, N. M., a distance of 290 river km. The period of record is 1948 through 1964. The rainfall in the river basin varies from more than 100 cm at the headwaters to less than 8 cm downstream. There is a general reduction in channel slope, water discharge, and particle size, and an increase in sediment load downstream. Sediment samples were taken daily, and computed monthly loads were used in the study. All water discharge spectra have peaks at 1 cycle per yr which are significant at the 95% level. Anywhere below Otowi, tributary flow is likely to contribute little water but much sediment, which makes sediment variation greater than that of water discharge. Harmonic analysis shows that cyclic models can explain 25% of the variance in water discharge and 15% in sediment discharge. The random parts are the more important components. Cross-spectral analysis between water and sediment loads shows correlation coefficients of 0.5 to 0.9 at zero lag. (Knapp-USGS) W68-00837

SEDIMENT TRANSPORT IN CONVEYANCE SYSTEMS, PART I--A PHYSICAL MODEL FOR SEDIMENT TRANSPORT IN CONVEYANCE SYSTEMS.

LeHigh Univ., Bethlehem, Pa., and Middle East Tec Univ, Ankara, Turkey. Walter H. Graf, and Ertan R. Acaroglu.

Bull Int Ass Sci Hydrol, Vol 13, No 2, pp 20-39, June 1968. 20 pp, 3 fig, 1 tab, 18 ref.

Descriptors: *Flumes, *Sediment transport, *Model studies, *Hydraulic models, Sediment discharge, Analytical techniques, Theoretical analysis, Mathematical studies, Regression analysis, Correlation analysis.
Identifiers: *Sediment transport flume studies,

Functional equations, Shear intensity (Hydraulic).

A physical model is proposed and mathematically described in an attempt to explain total sediment load in a conveyance system which may be an open channel, a 'natural' river, or a closed conduit. Published experimental data are used in seeking verification of the model. Hydrodynamic forces on a stationary particle in a plane bed are calculated and the conditions at the time of first movement are described. The 'shear intensity parameter' for turbulent flow defines 2 distinct regions of flow conditions: flow without and flow with solid particles. If flow is turbulent, the particles are cohesion-less, the particles have a uniform size distribution, and saltation and suspension are the primary means of transport. In this case there is no need for distinction between bed load and suspended load transport mechanisms, and there will be a functional relationship between shear intensity and bulk rate of sediment transport. (Knapp-USGS) W68-00841

BEDROCK INFLUENCE ON SEDIMENT LOAD OF A SELECTED HARTWELL RESERVOIR TRIBUTARY,

Clemson Univ., Clemson, S. C.
Paul K. Birkhead, and V. S. Griffin, Jr.
Water Resources Research Institute, Report No. 6,
pp 1-48, July 1968. 48 p, 6 fig, 9 tab, 31 ref.

Descriptors: Provenance, Petrology, Watersheds (Basins), Reservoirs, Sedimentation, Sediments, Tributaries, Sediment yield. Identifiers: Amphibole gneiss, Biotite gneiss-granite gneiss, Biotite gneiss-biotite schist, Quartz, Sub-basin, Sediment contribution scale.

The important provanance lithologies in the Martin Creek drainage basin of Hartwell Reservoir are: (A) amhibole gneiss, (B) biotite gneiss-granite gneiss, and (C) biotite gneiss-biotite schist. Quartz is the major constituent in the sediment produced from the transported weathered products of the rocks. These lithologies contribute dispropor-

tionate amounts of quartz to the sediment. A system of equations was solved to find rA, rB, and rC, the quartz increase factors between bedrock and sediment of lithologies A, B, and C respectively. With I representing the overall quartz increase for the combined lithologies of the sub-basins of the tributary, units A, B, and C give rA/l, rB/l, and rC/I times the quartz they would produce if all lithologies gave proportionate shares to the sediment according to their individual quartz content and area. A sediment yield scale was formulated where the yield of lithology B = 1, yield of A = 4.86, and yield of C = 2.27. The method of derivation of the sediment yield scale would be applicable in other physiographically unique areas. (Author) W68-00893

SEDIMENT DISTRIBUTION IN TURBULENT FLOW.

Venezuela Central Univ., Caracas, Hydraulic Laboratory Konstantin Zagustin.

J Hydraul Res, Vol 6, No 2, pp 163-172, 1968. 10 p, 5 fig, 5 ref.

Descriptors: *Turbulent flow, *Viscosity, *Sediment transport, *Sediment distribution, Supercritical flow, Turbulent boundary layers, Suspension, Equations, Mathematical studies.
Identifiers: *Von Karman-Prandtl equation

An exponential analytical equation based on an expression for kinematic eddy viscosity is presented for sediment distribution in turbulent flow. The theoretical and experimental results coincide excellently over the entire flow region. An advantage of this analysis over earlier mathematical models is that finite concentration of sediment is obtained at the surface of the flow. Theoretical and experimental curves are presented graphically for comparison. (Knapp-USGS) W68-00947

THE CYCLE OF EROSION IN DIFFERENT CLI-

Sorbonne, Paris, France.

Pierre Birot.

Univ of California Press, Berkeley and Los Angeles, 1968. 144 p, 21 fig, 89 ref.

Descriptors: *Erosion, *Sediment transport, Geomorphology, Vegetation, Weathering, Cli-

Identifiers: *Erosion cycle, Climato-morphology, Fluvial dynamics, Textbook.

This textbook (translated from Portuguese) is intended to help remedy a shortage of works in English on the development of landforms in the various climatic regions. It discusses climato-morphology under the aspects of basic processes of the erosion cycle, and the influence of different climates on the cycle of erosion. The three basic processes covered in the first part are: the decomposition of rock into detritus; the transport of this detritus on slopes; and the transport of this detritus in the river bed and the erosion of the river bed itself. The classification of weathering processes based on the behavior of water is outlined in Chap I. Chap III provides examples of fluvial dynamics. The two principal methods of transport of material are examined separately (transport in suspension and transport on the bed-traction load). Effect of climato-morphology on the erosion cycle involves the vegetation cover, and vegetation is used as the basis of classifying the erosion systems. Erosion cycles are examined for these types of climate: normal, preglacial, tropical, arid and semiarid, and alternating wet and dry climates. References are cited for each chapter. (Llaverias-USGS) W68-00958

2K. Chemical Processes

EFFECT OF HIGH TEMPERATURES ON THE COMPOSITION OF GROUND CHEMICAL WATERS,

North Caucasus Branch of Civil Engineering Research Institute, Gosstroy, USSR, Stavropol. I. G. Kissin, and S. I. Pakhomov.

Geochem Int, Vol 4, No 2, pp 295-308, 1967. 14 p, 3 fig, 6 tab, 11 ref.

Descriptors: *Chemical reactions, *Geochemistry, Water chemistry, Clays, Ion exchange, Particle size, Shales, Leaching, Silts, *Water temperature, Geothermal studies, Hot springs, Thermal water, *Solubility, Aqueous solutions. Identifiers: *Exchange reactions, USSR.

Experiments were made on the interaction of claystone and siltstone with distilled water, sodium chloride solutions, and sodium-calcium chloride solutions at 20 to 200 deg C to approximate the conditions in deep artesian basins. A one-liter bomb with provision for temperature and pressure measurements to 500 deg C and 500 atm was charged with 850 ml of liquid and 170 g of rock crushed to less than 1 mm. The rock samples were taken from core holes in the Caucasus mineralwater region. Solution of easily soluble salts is rapid and the rate increases at higher temperatures. The solution of carbonates is also strongly influenced by temperature. Exchange reactions are affected both by temperature and by original solution composi-tion. High concentrations of leaching solution, par-ticularly if TDS is high while Ca is low, favor ex-traction of Ca and addition of Na to the rock. High temperature increases the importance of exchange reactions on the composition of groundwater. Sulfate concentration increases to 100 deg and decreases at 150-200 deg. Silica concentrations increase with temperatures as alumino-silicates begin to decompose at 100 deg, and the amount of decomposition increases with temperature. Considerable dissolved carbon dioxide is produced at higher temperatures. (Knapp-USGS) W68-00676

HYDROGEOCHEMISTRY OF GROUNDWATER IN CENTRAL ISRAEL, Geological Survey of Israel

Arnon Arad Int Ass of Sci Hydrol, Bull 11, No 1, pp 122-146, 1966. 25 p, 22 fig, 17 ref.

Descriptors: *Geochemistry, *Hydrogeology, *Chemical properties, lons, *Groundwater, Saline water-freshwater interfaces, Aquifers, Sandstones, Dolomite, Limestones, Sulfates, Bicarbonates, Chlorides, Recharge, Brines, Petrography, Percolation Mixing. tion, Mixing. Identifiers: Israel, Rift Valley, Dead Sea, Negev,

Hydrogeography, Hydrogeochemistry.

The area under study was the Foothills, the Judean Mountains and the Dead Sea Rift Valley. The climate ranges from semi-humid in the north to arid in the east. The aquifers are developed out of sand-stone, dolomite and limestone. The regional groundwater groups of central Israel included the bicarbonate waters representing the replenishment areas, chloride waters representing the confined and the base-level zones and the sulfate waters of the intermediate zones. Five hydrogeochemical groups of groundwater were distinguished on the basis of ion content. The four factors which affected the chemical evolution in the area under study were: the lithology of the aquifer and the adjoining rock formations, the degree of confine-ment, the degree of mixing between two or more different types of groundwater, and the rate of run-off water percolation into the aquifer. Ground-water mixing within the Dead Sea Basin produced waters with Mg greater than NA greater tha Ca and Cl much greater than So greater than HCO sub 3. All brines showed chemical compositions different from ocean water. (Blecker-Ariz) W68-00696

Group 2K—Chemical Processes

CHEMICAL ANALYSIS OF BRINES FROM SALT LAKES OF RAJASTHAN,

Defence Laboratory, Jodhpur, India. J. C. Chaudhuri, N. K. Sen, and T. N. Bhargava. Ann of Arid Zone, Vol 5, No 2, pp 248-254, Sept 1966. 7 p, 5 tab.

Descriptors: *Salt lakes, *Chemical analysis, *Brines, On-site data collections, Wells, Sodium chloride, Dissolved solids, Volumetric analysis, Sampling, Hydrogen ion concentration, Ions, Analytical techniques, Salts, Economic impact,

Identifiers: Rajasthan, India, *Anions, *Cations.

An analytical study of was brines made on four salt lakes of industrial potential in Rajasthan, India. The chemical analysis of brines was undertaken on a volume basis which facilitated periodical checks. The samples were collected in polythene bottles from Sambhar, Didwana, Pachbhadra and Phalodi lakes and examined for the following properties: pH; anions (chloride, sulfate, bicarbonate, carbonate, nitrate, nitrite); cations (calcium, magnesium, potassium, iron, ammonia); boron; and total dissolved solids. Methods and results of analyses were given. Variation in the composition of the brines could not be fully evaluated since necessary geological, geochemical, biological and climatolog-ical data were not available at that time. (Affleck-W68-00697

NOTES ON THE SULFUR CYCLE IN THE MINERAL WATERS AND ROCKS OF THE LAKE TIBERIAS-DEAD SEA RIFT VALLEY, ISRAEL,

Weizmann Inst of Sci, and Israel At Energy Comm, Rehovoth, and Geol Surv of Israel, Jerusalem. E. Mazor, and E. Rosenthal.

Israel J Earth Sci, Vol 16, No 4, pp 198-205, Dec 1967. 8 p, 3 fig, 2 tab, 4 ref.

Descriptors: *Geochemistry, *Water chemistry, *Groundwater, *Sulfates, Chemical analysis, *Groundwater, *Sulfates, Chemical analysis, Hydrogen sulfide, Pyrite. Identifiers: *Sulfur-sulfate cycle, Israel, Dead Sea

Rift, Hydrogeochemistry.

In geochemical cycle proposed for the waters and rocks of the Tiberias-Dead Sea Rift Valley, all waters of the Tiberias-Noit type originated from trapped ocean water. The Fulya-Barbutim-Tabgha sub-group retained the initial oceanic sulfate. In other waters, mainly around Lake Tiberias, sulfate is depleted, presumably because of bacterial decomposition with H sub 2 S formation. In the Dead Sea region this H sub 2 S is partly converted into pyrite, and the decomposed sulfate is continuously replenished by gypsum solution. This in-terpretation is supported by rock-leaching experiments and mineralogical determinations in drill samples. (Knapp-USGS) W68-00805

DEUTERIUM CONTENT IN NATURAL

WATERS, All-Union Institute of Applied Geophysics, Leningrad, USSR

. A. Molochnova, M. M. Sokolov, and A. V. Gorev

Geochem Int, Vol 4, No 3, pp 484-489, 1967. 6 p, 5 fig, 11 ref.

Descriptors: *Deuterium, *Groundwater, Stable isotopes, Rivers, Lakes, Running waters, Standing

Identifiers: *USSR, *Hydrogen isotopes, Ukrainian shield, Kazakhstan.

Deuterium contents of river and lake waters and 130 samples of groundwaters from Precambrian crystalline rocks (Ukrainian shield) and Paleozoic volcanic-sedimentary rocks (central Kazakhstan) were determined. River waters vary in deuterium oxide content from 0.0133 to 0.0156 mole %. Waters of large rivers and open lakes vary between 0.0147 and 0.0150 mole % deuterium oxide. The deuterium oxide content of the groundwater samples clusters closely about a mean value of 0.148 plus or minus 0.0003 mole %. Deuterium oxide contents of groundwaters tend to increase with depth but do not differ significantly from those of large rivers. High deuterium contents are found in waters with high salinity and high content of organic matter; low deuterium contents are characteristic of waters high in radioactive elements but of low salinity. (Knapp-USGS) W68-00816

ISOTOPIC COMPOSITION OF LEAD IN NATU-**RAL WATERS**

All-Union Institute of Applied Geophysics, Lenin-

grad, USSR. P. F. Andreyev, N. M. Bugrov, and V. S. Glebovskava

Geochem Int, Vol 4, No 3, pp 551-556, 1967. 6 p, 5 tab. 11 ref.

Descriptors: *Stable isotopes, *Groundwater, *Radioisotopes, *Lead radioisotopes, Rivers, Lakes, Running waters, Standing waters, Radiochemical analysis. Identifiers: *USSR, *Lead isotopes, *Isotopic anal-

Data on the isotopic composition of lead in surface and groundwaters of several regions of USSR are given, along with a detailed account of the technique the authors used in the field to concentrate the lead in the water samples. Waters of large basins (Sea of Azov, Lake Balkash) are isotopically similar; ground and surface waters of the Ukraine and Kazakhstan vary considerably in lead isotope composition. Groundwaters of Kazakhstan and the rocks through which these waters percolate contain lead of similar isotopic composition. The results of analysis of 65 samples are tabulated. (Knapp-W68-00817

WATER-MINERAL RELATIONS OF QUATER-NARY DEPOSITS IN THE LOWER PLATTE RIVER DRAINAGE AREA IN EASTERN NEBRASKA,

U. S. Geological Survey Ivan Barnes, and Ray Bentall. U S Geol Surv Water-Supply Pap 1859-D, pp D1-D39, 1968. 39 p, 6 fig, 7 tab, 10 ref.

*Groundwater, recharge, Effluent streams, Influent streams, Surface-groundwater relationships, *Aqueous solu-tions, Acidity, Vapor pressure, *Water chemistry, Calcium carbonate, Carbon dioxide, *Hydrogen ion concentration, Nebraska.

Identifiers: Partial pressure (Carbon dioxide), *Calcite saturation, Platte River, *Water-mineral

The partial pressure of carbon dioxide, the degree of saturation of calcite, the pH, and the concentrations of selected constituents in solution were determined for water from 52 wells and the Platte River. The average partial pressure of carbon dioxide in the groundwater was many times as great as in the atmosphere, and in the river water it was twice the atmospheric value. The source of the high carbon dioxide partial pressure in groundwater is probably the respiration of plant roots and microorganisms. Calcite saturation ranged from 0.141 to 1.29 in groundwater and averaged 9.6 in river water. No terrace-plain well water samples were supersaturated in calcite, but water from 7 of 42 floodplain city supply wells was. In 2 of the 7, hydrologic relations suggest recharge from the river. Calcite supersaturation of water from 5 of 9 wells downvalley from the city well field is probably caused by fragmental calcite in the Quaternary aquifer. Average pH in the city well water was unit lower than in river water. Several city wells had both dissolved iron and oxygen, which probably reflects mixing of older groundwater with river seepage. (Knapp-USGS) W68-00819 GELS COMPOSED OF SODIUM-ALUMINUM SILICATE, LAKE MAGADI, KENYA,
Johns Hopkins Univ., Dep of Geology and US

Geological Survey. H. P. Eugster, and B. F. Jones. Science, Vol 161, pp 160-163, July 12, 1968. 4 p, 4 fig, 3 tab, 14 ref.

Descriptors: *Geochemistry, *Gels, *Hot springs Chemical properties, Water chemistry, Silica Lakes, Lake beds, Alkaline water, Pleistocene epoch. Identifiers: *Kenya, Africa, *Lake Magadi

Trachyte, Algal mats.

Surficial deposits of sodium-aluminum silicate gels as thick as 5 cm, which occur in the Magadi area o Kenya are formed by the interaction of hot alkaling Kenya are formed by the interaction of hot alkalm springwater with alkali trachyte flows and thei detritus, rather than by direct precipitation. The springwaters range in temperature from 67 deg to 82 deg C, and have a pH of about 9. The sodium in the gel is from the springwater; the silica and alu mina in the gel are released from the rock by reac tion with the saline springwaters. Algal mats pro tect the gels from erosion and act as thermal insula tors, but periodic floods probably wash the gels into the lakes. Laboratory tests show the gels upor crystallization yield analcite which suggests that the lacustrine deposits that contain analcite may have formed from gels. Cherts in the Pleistocene rock in the area may have formed from soft sodium sil icate gels. (Lang-USGS) W68-00829

LIGNIN XIV. GEL CHROMATOGRAPHY AND THE DISTRIBUTION IN MOLECULAR SIZE OF LIGNIN SULFONATES AT SEVERAL ELECTROLYTE CONCENTRATIONS,

Washington Univ., Seattle, Department of Chemi Prem R. Gupta, and Joseph L. McCarthy.
Macromolecules, Vol 1, No 3, pp 236-244, May
June 1968. 9 p, 8 fig, 5 tab, 34 ref.

Descriptors: Gel chromatography, Lignin sulfonates, Molecular weight distributions, Pulp mil effluents, Column chromatography, Spent sulfite liquor Identifiers: Sephadex gels.

Sodium lignin sulfonates, from gymnosperm woods, were fractionated using Sephadex G-50 column and eluting with distilled water and/or sodi um chloride solutions of various molarities. The um chloride solutions of various molarities. In elution patterns of lignin sulfonates changed in systematic manner with respect to the molarity of the eluent. Molecular weights of fractions range from about 400 to 70,000. The sizes of the ligning the size of the size of the ligning the size of sulfonate polymer molecules in terms of equivalen Eistein spheres, r sub eta, were estimated from the measured molecular weights and from intrinsic viscosities calculated using relationships reported by Goring and coworkers. These ranged from about 7 to 70 angstroms. Support for the concep of change in molecular size with electrolyte con centration is found in the fact that column func tioning was correlated satisfactorily in terms o logarithm of the product of intrinsic viscosity am molecular weight versus V sub e, the elution volume; r sub eta versus K sub d, the fraction available of the volume of the gel liquid, and r sul eta versus the inverse error function complemen of K sub d. (Gupta-Wash) W68-00910

USE OF ATOMIC ABSORPTION SPEC TROMETRY TO STUDY THE DISTRIBUTION OF TRACE ELEMENTS IN VARIOUS HYDROLOGICAL AND GEOLOGICAL EN VIRONMENTS, Nevada Univ, Reno.

P. A. Weyler. Proj Rep 8, Center for Water Resour Res, Uni Nev, Oct 1966. 9 p, 4 photo.

Descriptors: *Chemical analysis, Spectroscopy Elements (Chemical), Metals, *Trace elements Hydrology, Geology, Rocks, *Water analysis.

Identifiers: *Atomic absorption analysis.

The project purpose was to utilize atomic absorption analysis methods to determine the distribution of trace elements in various hydrological and geological environments. The atomic absorption equipment is used to run cheap, rapid, yet accurate, analyses as needed by the various projects of the Center for Water Resources Research and the Nevada Bureau of Mines. W68-01018

2L. Estuaries

PROPOSED PROJECT FOR A SALINITY PROBLEM AT ABADAN, Iran. Ministry of Water and Power, Irrigation Administration. Teheran and U. S. Agency for International Development.
M. B. Gholizadeh, and Albert T. Petersen.
Amer Soc Civil Eng J, Vol 93, No IR1, Proc Paper 5138, pp 43-63, March 1967. 21 p, 6 fig, 6 tab, 2 append.

Descriptors: *Salinity, *Agriculture, *Discharge (Water), *Saline water intrusion, *Irrigation programs, *Tidal effects, *Water quality, Sea water, Deltas, Rivers, Dates, Runoff, Industrial water, Plant growth, Flood control, Streamflow, Multiplepurpose projects, Economic impact. Identifiers: Iran, Irrigation agriculture.

The paper summarizes results of field and office work done from 1962 to 1966 on the problem of periodic incursions of sea water into the delta of Shatt-Al-Arab and Karoon Rivers at Abadan since 1925. High salinities prevail downstream in both Shatt-Al-Arab and Bahmanshir Rivers in concentrations and in duration sufficient to severely reduce date production and eventually kill existing data palms as far upstream as Abadan. Sea water intrusion into the estuary is related to height of tides, upland discharges and other factors. Both flood and normal upland discharges in the Shatt-Al-Arab River are being brought under control and diverted for consumptive use in Turkey, Syria and Iraq. With upland stream regulation, minimum discharges of approximately 300 cumecs at Ahwaz should be maintained to prevent incursion of sea water into the Bahmanshir River up to the Abadan pump station for the next 10 or 15 yrs. The Karoon River appears to be the most secure future source of water for the Abadan area. Since upstream regulated discharges of the Shatt-Al-Arab River directly affect agriculture and industries of both Iraq and Iran, closer technical cooperation between them for investigation and control of salinity problems would be mutually beneficial. (Blecker-Ariz) W68-00723

03. WATER SUPPLY **AUGMENTATION** AND CONSERVATION

3B. Water Yield Improvement

WATER IN ORANGE COUNTY, FLORIDA, U. S. Geological Survey, Tallahasee, Florida. B. F. Joyner, W. F. Lichtler, and Warren Anderson.

Florida Div Geology Leafl No. 8, 1968. 16 p, 12 fig,

Descriptors: *Water resources, *Florida, *Groundwater, *Artesian wells, Municipal water, Recreation, Water yield, Surface waters, Lakes, Aquifers. Identifiers: *Orange County, Florida, Orlando,

Information was condensed from 'Water Resources of Orange County, Florida': Fla. Geological Survey Report of Inv. No. 50, 1968, by the same authors, into a leaflet that clearly and concisely describes the water resources of the Orlando area. An average of 52 in. of rain falls on Orange County in a year. ABOUT :% IN. RETURNS TO THE AT-MOSPHERE BY EVAPORATION AND PLANT TRANSPIRATION. About 17 in. recharges the groundwater reservoirs and helps maintain stream-flow. Lakes in Orange County contain water that is soft, low in mineral content, and often highly colored because of dissolved organic matter. Groundwater is in a water table aquifer composed of about 40 ft of sand, and 2 underlying artesian limestone aquifers. The nonartesian water is generally soft, low in mineral content, slightly corrosive, and sometimes high in iron content. The artesian water is hard, nearly everywhere of good quality, but salty in the easternmost part of the county. Wells yield as much as 4,000 gpm when properly completed. Water levels range from more than 100 ft deep in the highlands to over 15 ft above the surface in the eastern low parts of the county. Total pumpage is about 80 mgd, of which 11 mgd is used by Brevard County. Supplies are ample for present and projected future needs. (K-napp-USGS)
W68-00655

THE ARAL SEA PROBLEM AND ITS SOLU-

Institute of Mineral Resources, Dnepropetrovsk I. M. Chernenko.

Soviet Geogr Rev and Transl, Vol 9, No 6, pp 489-492, June 1968. 4 p, 8 ref.

Descriptors: *Water supply, Irrigation, Artesian water, *Water management (Applied), *Water resources development, Deserts, Runoff, *Surfacegroundwater relationships.

Identifiers: *USSR, Desert basin development,

It is suggested that 90% of the present streamflow into the Aral Sea can be diverted without causing the sea to dry up. Subsurface flow into the sea through 20 artesian aquifers with a total thickness of 1,000 m and a head of 10 to 14 m above present sea level is estimated to be 5.5 cu km per yr. Lowering of sea level will increase flow an esti-mated 0.5 cu km per yr for each meter of sea level decline. Lowering the sea level 12 m, then, will increase inflow to about 12 cu km per yr which equals all the present surface and surface inflow and will stabilize the sea level. In addition, it will cause the streams to cut down so that presently wet lands will discharge their water into the lake, and transpiration by reeds will cease. The sea's area will be reduced from the present 64,000 sq km to 38,800 sq km, and the mineralization will increase from 10.3 to 24 gpm per liter. (Knapp-USGS) W68-00663

PRELIMINARY REPORT ON THE WATER RESOURCES OF THE KONA AREA, HAWAII,

U. S. Geological Survey Dan A. Davis, and George Yamanaga. Hawaii Div Water and Land Develop Circ C46, June 1968. 22 p, 6 fig, 2 tab, 11 ref.

Descriptors: *Water resources, *Hawaii, *Groundwater, *Surface waters, Municipal water, Water wells, Aquifers, Water table, Runoff, Discharge (Water), Recharge, Basalts, Water quality, Cli-

matic data, Water storage. Identifiers: *Kona, Hawaii, Preliminary water-resource report, Water availability, Surface catchments (Artificial).

The available hydrologic data for the Kona area on the west coast of Hawaii are summarized. The rainfall ranges from 15-40 in. per yr on the 13,000-ft high mountain tops to 75-100 in. at altitudes between 1,200 and 3,500 ft. Slopes are smooth and undissected; there are no perennial streams; and no surface water enters the ocean except during intense rains because almost all precipitation can in-filtrate immediately. Until deep well water supplies were developed, almost all the domestic water supply was from tanks filled by roof catchments. An experimental surface catchment, operated for 3 yr, showed that 16,940 sq ft would supply 2,000 gpd from an annual rainfall of 79 in. if 240,000 gal of storage space were available. The only groundwater source is the basal aquifer where the land surface is near sea level. The water is brackish at pumpage was a little more than half a million gpd in 1966. (Knapp-USGS) W68-00667

GROUND-WATER RESOURCES IN THE VICINITY OF THE CROWN POINT FISH HATCHERY ESSEX COUNTY, NEW YORK, U. S. Geological Survey, Albany, New York

I. H. Kantrowitz.

Water Resources Comm Rep Invest RI-2, 1968. 13 p, 5 fig, 2 tab.

Descriptors: *Water resources, *Groundwater, *Water wells, *Water sources, *Water yield, Springs, Hydrologic data, Aquifers, Water table, Water levels, Observation wells, Hydrologic properties, Specific capacity, Transmissivity, Surface-groundwater relationships, Fish hatcheries. Identifiers: *Pumping-test data, Aquifer tests, Test

An investigation was made to locate and evaluate Additional groundwater supplies for the Crown Point Fish Hatchery. Existing surface water sup-plies are adequate in quantity but too variable in temperature for year-round use, and present springwater supplies are insufficient. As much as 350 gpm having a temperature between 7 and 13 deg C is required. Test trenching near the present spring supply showed that the ice-contact glacial drift aquifer is thin, and the spring flow cannot be increased. A seismic survey revealed thick uncon-solidated deposits in a valley near the hatchery. Putnam creek loses 800 gpm to the valley fill. Data from pumping test holes indicate a water-table aquifer with a transmissivity of 57,000 gpd per ft adulter with a transmissivity of 57,000 gpd per ft and storage of 0.26 with an impermeable boundary 50 ft from the well. The aquifer can be expected to yield 200 gpm from 2 wells 100 ft apart for at least a 200-day period. (Knapp-USGS) W68-00672

GROUND WATER RESOURCES OF THE BELHAVEN AREA NORTH CAROLINA,

U. S. Geological Survey, Raleigh, North Carolina. Orville B. Lloyd, Jr., and Edwin O. Floyd. North Carolina Div Ground Water Rep Invest No. 8, 1968. 38 p. 13 fig, 4 tab, 11 ref.

Descriptors: *Groundwater, *Artesian wells, *Hydrologic data, *Water quality, Water wells, Aquifers, Logging (Recording), Chemical analysis, Water levels, Hydrogeology, Data collections, Water level fluctuations, Observation wells, Water yield, Specific capacity, North Carolina, Coastal relains

Identifiers: Well data, Pumping-test data, Test holes, Water-level measurements, Belhaven, N.C.

An investigation of the groundwater resources of the Belhaven area was made because lowering of water levels, increased needs, and possible saltwater encroachment caused extensive public water supply problems. The study area is in northeastern Beaufort County, in the Coastal Plain, and is underlain by 2,500 ft of sand, silt, clay, shell, and limestone beds of Cretaceous to Recent age. limestone beds of Cretaceous to Recent age. Between the surface and a depth of 300 ft there are netween the surface and a depth of 300 ft there are 3 fresh-water aquifers, the lower 2 of which are artesian. Below 300 ft the water is salty. Yields range from 1 gpm per ft in the upper to 80 gpm per ft in the lower aquifer. Large withdrawals of water by open-pit phosphate mining SW of the area have caused about 12 ft of lowering of water levels in the lower aquifer near Belhaven, increasing the danger of salt-water encroachment. The other aquifers are or salt-water encroachment. The other aquifers are relatively unaffected and can provide a good water supply if the lower aquifer becomes inadequate. Groundwater in the area is hard and of generally good quality. Locally it may contain excessive amounts of iron, chloride, or hydrogen sulfide. (Knapp-USGS) W68-00673

Field 03—WATER SUPPLY AUGMENTATION AND CONSERVATION

Group 3B-Water Yield Improvement

HIGH ALCOHOLS AS ANTITRANSPIRANTS, University of California, Davis, Department of Water Science and Engineering.
J. Gale, Edwin B. Roberts, and Robert M. Hagan.

Water Resources Research, Vol 3, No 2, pp 437-441, 1967. 5 p, 2 tab, 20 ref.

Descriptors: *Alcohols, *Transpiration control, *Monomolecular films, *Plant growth substances, Plant growth, Reservoir evaporation, Retardants, Hexadecanol, Photosynthesis, Water loss, Weight, On-site investigations, Correlation analysis.

Attention has been given in recent years towards the reduction of reservoir evaporation by the appli-cation of higher alcohols to the surface of water. It has been considered possible that such material, if made to form a film on the mesophyll surface of plants, would constitute effective antitranspirants. The results of seventeen such investigations indicate that at concentrations that reduce transpiration, these materials also reduce plant growth. When corn plants were treated with hexadecanol flakes at the rate of 25 and 50 lbs/acre, plant growth was reduced, transpiration tended to increase, and signs of a possible potassium deficiency were present. (Blecker-Ariz) W68-00691

RECENT RESULTS OF THE ISRAELI ARTIFI-CIAL RAINFALL STIMULATION EXPERI-

Israel, Hebrew University, Jerusalem K. R. Gabriel. J of Applied Meteorol, Vol 6, No 2, pp 437-438, April 1967. 2 p, 2 tab.

Descriptors: *Rainfall, *Cloud seeding, *Artificial precipitation, *Rainfall disposition, Seasonal, Wet seasons, Dry seasons, Silver iodide, Variability, Meteorological data, Statistical methods, Correla-tion analysis, Precipitation intensity. Identifiers: Israel.

A randomized experiment of seeding clouds with Agl (silver iodide) from aircraft has been in operation in Israel since 1961. The experiment runs throughout the rainy season of each year and is evaluated by a crossover comparison of amounts of precipitation in the two areas on the two types of days, designated either to be North seeded or Center seeded. The percentage of additional rainfall varies from season to season but was increased 18-19% on the average for the entire experiment. The data suggests that seeding may have occasionally very strong effects and little or no effect on most days. (Blecker-Ariz) W68-00692

THE INFLUENCE OF INTRASECULAR VARIATIONS OF WETNESS OF LAKE BASINS UPON THE DEVELOPMENT OF THEIR DEPRES SIONS,

Leningrad Univ., USSR, Lake Research Laborato-

For primary bibliographic entry see Field 02H. For abstract, see W68-00842

DRILLED WATER WELLS IN NEW HAMPSHIRE,

New Hampshire Univ., Durham. Glenn W. Stewart.

N H Dep of Resources and Econ Develop Mineral Resources Surv Part 20, 1968. 58 p, 15 fig, 1 tab, 33 ref, 1 append.

Descriptors: *Groundwater, *Water wells, *New Hampshire, *Hydrologic data, *Water yield, Hydrogeology, Data collections, Specific capacity, Aquifers, Statistical methods, Estimating, Probability, Statistical methods, bility, Statistical models. Identifiers: *Drilled wells, Predicted yield.

Data on the locations, stratigraphy of rocks penetrated, depth, yield and depth to bedrock are compiled for 6,058 wells drilled into jointed igne-

ous and metamorphic rocks in New Hampshire. Relationship of yield to depth, depth distribution of wells, and yields are presented graphically. The data have also been tabulated, averaged, and punched on cards for statistical analyses. Questions about depth of drilling, expected yield, location of wellsites, and depth of bedrock can be answered by use of this compilation and analysis. Investment alternatives are presented in terms of probability of yield. Statistical analysis shows no relation of yield to rock type, but only to the amount of jointing. The average well yield in metamorphic rocks is 13.4 gpm and in igneous rocks it is 10.3 gpm. Topography, jointing, depth of nearby wells, and geographic location were analyzed statistically to obtain predictions of well success. The statistical model used is in the appendix. LeGrand's point system for predicting well yield is included with a warning that its predictions are high for New Hampshire conditions. (Knapp-USGS) W68-00955

STATUS OF EVAPORATION MEASUREMENTS IN THE UNITED STATES.

U S Geological Survey For primary bibliographic entry see Field 02D. For abstract, see.

WATER FOR OKLAHOMA,

U S Geological Survey For primary bibliographic entry see Field 06D. For abstract, see .

WATER AND WASTEWATER ENGINEERING, Harvard Univ, Johns Hopkins Univ, and Univ of N

Gordon Maskew Fair, John Charles Geyer, and

Daniel Alexander Okun. John Wiley and Sons, Inc, N Y, 1966-1968. Vol 1, 471 p; Vol 2, 659 p.

Descriptors: *Water supply, *Waste water disposal, *Municipal water, *Water management (Applied), *Sanitary engineering, Waste treatment, Hydrology, Water policy, Municipal wastes, Environmental engineering. Identifiers: *Textbook, Water-supply engineering.

This two volume textbook is intended to be used not only by students but also by practicing sanitary and water-supply engineers, and urban planners. Although it is assumed that all users will be competent in mathematics and engineering sciences, some elementary hydrology, physics, and chemistry are included for reference where refreshment in these subjects might improve understanding. Each chapter includes both the scientific and engineering aspects of water engineering and the cultural and historical perspective. Vol 1, subtitled 'Water Supply and Wastewater Removal,' treats water supply and wastewater removal in eighteen chapters which include design of water-handling facilities, the surface and underground sources of supply, elements of hydrology, information analysis, and optimization techniques. Vol 2, subtitled Water Purification and Wastewater Treatment and Disposal,' with twenty chapters, treats the physical, chemical, and biological aspects of the qualitative management of water. Qualitative needs are defined, theories of treatment are presented, and methods of obtaining water of the required quality are described. (Knapp-USGS) W68-00966

RESEARCH ON EVAPORATION REDUCTION **RELATING TO SMALL RESERVOIRS, 1963-65,** Arizona Univ, Tucson, Institute of Water Utilization, Agr Exp Station.

C. Brent Cluff.

Ariz Agr Exp Sta Tech Bull 177, Univ of Ariz, Tucson, Ariz, Oct 1966. 47 p, 22 fig, 5 tab, 19 ref.

Descriptors: *Evaporation control, *Reservoir evaporation, *On-site tests, *Laboratory tests, *Evaporation pans, Monomolecular films, Arid lands, Alcohols, Emulsifiers, Viscosity, Particle size, Economic feasibility, Modecular structure, Retardants, Equipment, Instrumentation, Chemi-

Identifiers: *Dispensers, *Spreading rates, *Windactivated equipment.

Studies were made from 1963 to 1965 on the effectiveness of monomolecular films for evaporation reduction on small reservoirs in arid regions at the Institute of Water Utilization Research Center, Tucson, Ariz. Tests were made in the laboratory, U. S. Weather Bureau Class A evaporation pans, three 53 by 78 ft reservoirs, and one 80 by 210 ft reservoir. The optimum concentration of long chain normal alcohols and emulsifiers was found to be more dependent on viscosity characteristics than on particle size and spreading rate. The best combination of alcohol and emulsifier with the wind activated emulsion dispenser was found to be 10% alcohol with a 0.04 emulsified alcohol ratio. Float dispensers for applying semi-solid emulsion were impractical because of the crusting of the emulsified alcohol. Evaporation suppression using monolayers on pounds less than one acre in size was not economically competitive with other methods such as floating covers on reduced surface area to volume ratio. (Affleck-Ariz) W68-00999

WATER **HARVESTING** PLAN. FOR LIVESTOCK OR HOME,

Arizona Univ, Tucson. C. Brent Cluff.

Progressive Agr in Arizona, Vol 19, No 3, pp 6-8, May-June 1967. 3 p, 6 photo.

Descriptors: *Water harvesting, Polyethylene, *Plastic, Arid climate, *Rainfall, Gravels.

The use of chemically inert plastic holds considerable promise, both in treatment of catchment areas and the sealing of storage tanks in the arid parts of and the sealing of storage tanks in the and pairs of the world. A pea-gravel cover was tested in an effort to increase the effective life of a plastic catchment. Six-mil b polyethylene plastic was covered with a one-inch layer of pea gravel. On 28 of the 33 rainfall events, runoff was obtained for a total of 10.58 inches or 87.5% of the rainfall. A plastic-laying gravel spreader was also developed. (Blecker-Ariz) W68-01008

3C. Use of Water of Impaired Quality

SURFACE IRRIGATION WITH SALINE WATER ON A HEAVY CLAY SOIL IN THE MEDJERDA VALLEY, TUNISIA, Institute for Land and Water Management Research, Wageningen, Netherlands. J. A. van't Leven, and M. A. Haddad. Land and Water Manage Res Tech Bull No 54, pp 281-303, 1968. 23 p, 8 fig, 16 tab, 11 ref.

Descriptors: *Irrigation, *Experimental farms, Saline water, Soil texture, Crop response, Ground-

water movement, Irrigation design, Return flow, Irrigation practices, *Irrigation effects, Irrigation water, Drainage effects, Evapotranspiration, *Leaching, *Soil-water-plant relationships, Chemical conducts cal analysis.
Identifiers: *Medjerda Valley, Tunisia, *Soil characteristics, Salinity regime, Discharge curves

(Water).

Because soil texture and salinity of the irrigation Because soil texture and salinity of the irrigation water used in the Medjerda Valley would lead to a salinization problem, the Tunisian Government set up an experiment in the valley, in which relationships of climate, saline water irrigation, drainage, soil salinity, crop growth, and crop rotation could be studied. The Medjerda Valley is a low delta with

Conservation in Industry—Group 3E

clayey silt soil, a high water table, and saline groundwater. It is drained with tiles on 60 m centers, 150 cm deep. The irrigation water has a salt content over 2,000 ppm. The experimental field is 14 hectares in area and is divided into 4 sections on each of which a different crop rotation and drain spacing was practiced. Soil water samples were taken monthly and the salinity measured. There was no great difference in salinity with different drain spacings. After 2 yr of growing artichokes no harmful effect was observed from irrigating with saline water. Corn and alfalfa caused higher salinity than artichokes but the level was not dangerous. A crop rotation which includes fallow periods, wintercrops, and perennials with a summer rest period is recommended. (Knapp-USGS) W68-00661

SALINITY PROBLEMS AND MANAGEMENT

IN RIVER SYSTEMS, California University, Los Angeles Arthur F. Pillsbury, and Harry F. Blaney. Amer Soc of Civil Eng J, Vol 92, IR1, Proc Paper 4733, pp 77-90, March 1966. 14 p, 1 fig, 1 tab, 37 refs, 1 append.

Descriptors: *Salinity, *Riverbasin development, Consumptive use, *Water quality control, Watershed management, Drainage water, River *Salt balance, Water supply, Salts, Saline water, Plant growth, *Degradation (Stream), Multiple-purpose projects, *Salt tolerance.

The paper is an attempt to explore the many interactions involved and to outline the factors that must be considered in river-basin planning. The principle of salt balance applied to a river system is that although man may consumptively use a part of a water supply for the irrigation of crops, all of the salt in that water must eventually be passed downstream. Developments in a river basin system result in a reduction in the quantity of water availaresult in a reduction in the quantity of water available downstream and in a progressive deterioration of the quality of that water. The nature of salts in water and the effects of salts on plants are discussed. The degradation ratio concept is explained. Salt management possibilities are discussed using watershed, river and irrigation projects along the river. The opportunities to improve jects along the river. The opportunities to improve the management of river-basin systems throughout, from the watershed to the extreme lower end of the basin, are summarized. (Blecker-Ariz) W68-00713

WHEN SALT TAKES OVER,

W. E. Matheson.

J of Agr (South Australia), Vol 7, No 8, pp 266-272, March 1968. 7 p, 2 fig, 4 photo, 1 tab.

Descriptors: *Salts, Vegetation effects, Land clearing, *Salinity, Drainage, Saline water intrusion, Toxicity, Soil moisture, Plant growth, Sea spray, Soil reclamation, *Halophytes, *Soil-water-plant relationships, Salt tolerance, *Saline soils, Stocking, Coasts, Rainfall.

Clearing of natural vegetation, high stocking rates, and poor drainage have all contributed to the increase in the area of salt-affected land in South Australia. Districts most affected are southern Eyre Peninsula, Kangaroo Island and Yorke Peninsula. The main salt in saline soils is common salt. Plants The main salt in saline soils is common salt. Plants are affected by salts in two ways. Salts may contain minerals which are directly toxic to plants or salts may be of the type which cause soil to hold water so tightly that plants are unable to get sufficient moisture for proper growth. Most of the salt which has accumulated in salt patches has originated from nas accumulated in salt patches has originated from salt in sea spray blown inland by strong winds and deposited in falls of rain. The three main types of salt patches found are highland salt patches, hill-side seepages and lowland salinity on drainage lines and poorly drained flats. Ways in which to reduce the salt problem of an area are discussed. A list of salt tolerant shrubs, legumes and trees is given salt tolerant shrubs, legumes and trees is given. (Blecker-Ariz)

W68-00721

SEASONAL VARIATIONS IN THE COMPOSITION OF SOME SALINE IRRIGATION WATERS OF WESTERN RAJASTHAN, Central Arid Zone Research Institute, Jodhpur, In-

I. C. Gupta, and C. T. Abichandani. Ann of Arid Zone, Vol 6, No 2, pp 108-116, Sept 1967. 9 p, 1 tab.

Descriptors: *Saline water, *Irrigation water, *Groundwater, Ions, *Water chemistry, Electrical conductance, Conductivity, Alkalinity, Salt balance, Calcium, Sodium, Magnesium, Hydrogen ion content, Wells, Chlorides, Sulphates, Carbonates, Recharge, Monsoons, Adsorption, Variability, Cation adsorption.

Identifiers: Rajasthan Desert, India, *Cations, Anions.

Saline ground waters from seven sites in Jodhpur and Pali districts of western Rajasthan, India, were analyzed for pH, electrical conductivity, and for cation and anion content to determine seasonal variation in salt composition. It was the sum total of these changes that would ultimately determine the salt balance and sodic effects in soils irrigated by these waters. Salinity varied from 2,316 to 10,160 micromhos. EC/cm during the season of wheat cultivation. Sodium was the dominant cation in all the waters, magnesium the second dominant followed by calcium. Chloride was the dominant anion, followed by sulfate and carbonate. The sodium adsorption ratios were far above ten during the irrigation season from October to March except for two sites. Recharge of waters in the wells was prominent after the start of the monsoon season causing a decrease in the concentration of sodium and chloride ions and a sharp drop in the sodium adsorption ratio. Those sites whose recharge source was close by showed more seasonal fluctuation in salinity levels than sites with recharge source further away. (Affleck-Ariz) W68-00736

USING SALT TO INCREASE IRRIGATION

WATER, Arizona Univ, Tucson. C. Brent Cluff, and Gordon R. Dutt. Progressive Agr in Arizona, Vol 18, No 3, pp 12-13, May-June 1966. 2 p, 4 photo.

Descriptors: *Sodium chloride, Irrigation water, *Surface runoff, Watersheds (Basins), Soil types, Rainfall, *Water harvesting.

Soil scientists have long known that sodium greatly affects the rate of movement of water into and through soils. To test the theory that sodium salt, when applied to watersheds, will increase runoff, a test was set up in Arizona. Pans containing three different soil types and concentrations of salt were subjected to normal rainfall. Water yields ranged from none on the untreated soil to 49% water yield from the treated soil (30% exchangeable sodium percentage in the surface inch of soil). Two oneacre plots on the Atterbury Experimental Watershed located on the valley floor east of Tucson, Arizona were selected to test the theory on a large scale. The sodium chloride treatment increased runoff about 25 times. The runoff water contained less than 200 parts per million dissolved salts. (Blecker-Ariz) W68-01009

3D. Conservation in Domestic and Municipal Use

UTILITIES AND INDUS CORP V PALISADES INTERSTATE PARK COMM'N (DAMS AND NATURAL FLOW).
45 Misc 2d 1014; 258 N Y S 2d 700 (Sup Ct Orange County 1965).

Descriptors: *New York, *Contracts, *Water rights, Natural flow, *Dams, Natural flow doctrine, Parks, Administrative agencies, Waterworks, Impounded water, Alteration of flow, Obstruction of flow, Spillways, Streamflow, Storage capicity, Judicial decisions, Siphons, Relative rights, Water allocation, Water demand.

This was an action by a water supply corporation asserting prior right to water against park commissioners under a contract allegedly entitling it to withdraw water from a manmade lake when the water level was below the spillway. The contract stated that a dam constructed by the commission to create a lake would not decrease the amount of water flowing down a brook to supply plaintiff's facilities. After construction of the dam, in dry seasons no water flowed down the brook, so plaintiff placed siphons over the dam to provide water for its facilities. Since 1940, defendant has charged plaintiff a fee for these withdrawals. The court construed the contract to mean plaintiff had a right only to natural flow after the dam was built, and not to withdraw water from the lake below spillway level. If plaintiff experienced a shortage during dry seasons it should have constructed additional storage facilities to collect the excess water which flowed over the dam in wet seasons. The contract did not confer upon the corporation unlimited right to withdraw waters impounded by the dam and not running over spillway. (Kirkconnell-Fla) W68-00793

MITCHELL V VILLAGE OF CROTON-ON-HUDSON (CONDEMNATION FOR WATER SUPPLY).

23 App Div 2d 812; 258 N Y S 2d 201-205 (1965).

Descriptors: *New York, *Water storage, *Administrative agencies, *Water tanks, Water supministrative agencies, water tanks, water sup-plies, Administrative decisions, Water utilization, Judicial decisions, Legislation, Condemnation, Regulation, Water sources, Reservoir storage, Storage tanks, Reservoirs, Water works, Water

Identifiers: Injunction, *N Y Water Resources

This was an action by taxpayers to enjoin a village from constructing a water storage tank upon condemned premises on the ground that approval of the State Water Resources Commission was a necessary prerequisite to such construction. The village proposed to fill this new storage tank with water obtained through existing water supply facili-ties in the Croton River. The New York Conservation Law requires Commission approval for any project wishing to 'acquire or take a water supply or additional water supply from an existing source or to 'take or condemn lands for any new or addior to take of condemn lands for any new of additional source of water supply or for the utilization of such supply. The court found that the new facility would not result in an increase in the total amount of water taken. The village had sought and received advice from the Commission that prior approval was unnecessary. Defendant's storage tank will in no way create a new water supply or enlarge the existing water supply. The injunction was denied. (Kirkconnell-Fla) W68-00794

3E. Conservation in Industry

HERKIMER PULP AND PACKAGING CORP V MCMORRAN (IMPOUNDING STRUCTURES IN ARTIFICIAL WATER WAY).

24 A D 929, 264 N Y S 2d 848-850 (1965).

Descriptors: *New York, Judicial decisions, Legislation, Water law, Administrative decisions, *Artificial watercourses, *Impoundments.

Respondent Herkimer Pulp and Packaging Corporation brought a proceeding to annual an order of the appellant McMorran, state superintendant of public works. The appellant had ordered the

Field 03-WATER SUPPLY AUGMENTATION AND CONSERVATION

Group 3E—Conservation in Industry

respondent to make changes in its structures for impounding water in its canal complex pursuant to New York Conservation Law, section 948. The Supreme Court, Appellate Division, affirming the opinion of the Special Term annulling the order, offered an additional ground. The court held that section 948, which provided the authority for the su-perintendant's action, must be construed to relate only to impounding structures in natural streams and natural watercourses. All of respondent's structures were in artificial streams and watercourses. (Patterson-Fla)

3F. Conservation in Agriculture

THE WATER PROBLEM IN THE DESERTS OF THE USSR.

All-Union Research Institute for Water Engineer-

ing and Reclamation, Moscow. L. V. Dunin-Barkoviskiy. Soviet Geogr Rev and Transl, Vol 9, no. 6, pp 458-468, June 1968. 11 p, 7 ref.

Descriptors: *Water supply, Dams, Desalination plants. Groundwater. Inter-basin transfers. plants, Groundwater, Inter-basin transfers, Pipelines, *River basin development, Snowmelt, Water conveyance, *Water management (Applied), *Water resources development, Weather modification, *Irrigation, Irrigation canals, *Deserts.

Identifiers: *USSR, Central Asian Deserts.

The existing and planned irrigation projects in the deserts of the Soviet Union are reviewed. Most of the desert zone water flows into the deserts in rivers. Most local precipitation evaporates immediately and more of the inflowing river water is lost to evapotranspiration than is used in crop production. The total irrigated area is 200,000 to 300,000 hectares, which might be increased to 15-20 million hectares if the waters of the Volga and some of the northern streams were used. Salinization of the soil will be a problem unless drainage projects are also constructed. Weather modification schemes, desalination plans, and the control of water budgets of wild plants are all being considered to help increase the water available for irrigation. (Knapp-USGS) W68-00662

EFFECTS OF SEASONAL VARIATION IN RADIATION AND TEMPERATURE ON NET ASSIMILATION AND GROWTH RATES IN AN ARID CLIMATE,

Australia, CSIRO, Division of Plant Industry, Can-

For primary bibliographic entry see Field 021.

For abstract, see W68-Q0688

SPAIN WILL IRRIGATE ARID SOUTH.

Engineering News-Record, Vol 179, No 19, p 63, Nov 9, 1967. 1 p, 1 map.

Descriptors: *Arid lands, *Tunnels, *Irrigation programs, *Water resources development, Rainfall, Dams, Rivers, Water supply, Moisture deficit, Aqueducts. Identifiers: Spain.

The government of Spain has launched a \$150-million irrigation project to make up for some of nature's inequities in rainfall. By 1972, the Bolarque-Talave system which will include Spain's longest water tunnel (15 ft-diameter and 20 miles long) will carry 1.2 million acre-ft of water each year to the dry, agricultural southeast. Water impounded by the Bolarque Dam on the Tagus River will be the project's supply source. The area around Murcia is expected to translate its new water supply into oranges and vegetables worth about \$50 million in annual export sales. (Blecker-Ariz) W68-00690

LAND FORMS, WATER AND LAND USE WEST OF THE INDUS PLAIN,

International Training Centre for Aerial Survey, Delft, Netherlands.

For primary bibliographic entry see Field 02A. For abstract, see . W68-00695

RAFTS: A N EVAPORATION, NEW WAY TO CONTROL

Arizona University, Water Resources Research Center, Tucson. Brent Cluff.

Crops and Soils Magazine, Vol 20, No 2, pp 7-9, Nov 1967. 3 p, 6 photo.

Descriptors: *Reservoir evaporation, *Evaporation control, *Arid climates, *Water tanks, Monomolecular films, Water loss, *Ponds, Water temperature, Economic feasibility, Plastics, Retar-

Identifiers: *Rafts.

Loss of water from small ponds is a serious problem in arid climates. The solution is to cover the water and to avoid raising the water temperature at the same time since warm water evaporates faster. One of the most promising methods for reducing evaporation on small reservoirs is by floating covers or rafts. Small rafts - 8 by 8 feet - have several advantages. Directions are given on how the rancher can use the rafts to conserve the water in his stock tanks. Different materials used in raft construction and their economic advantages are discussed. A brief note on the use of monolayers to control evaporation on large ponds is given. Blecker-Ariz) W68-00707

PASTURE PITTING IMPLEMENTS RATED,

Oklahoma State University, Agricultural Engineering Department.

Richard W. Whitney. Crops and Soils Magazine, Vol 20, No 9, p 20, August-Sept 1968. 1 p, 1 photo.

Descriptors: Water storage, Arid climates, *Pasture management, *Soil moisture, *Farm equipment, Resistance, *Retention, Semiarid cli-Moisture availability, Germination, Weathering. Identifiers: *Pitting.

In arid and semi-arid regions, pasture pitting can improve pastures by increasing the moisture retained by soils and providing the needed moisture for seed germination. Each implement was used to form pits and their water holding capacity and resistance to weathering were measured. The implements were a lister, rotary subsoiler, disk plow with an eccentric furrow wheel, and a bush and bog harrow with cutaway blades. The disk plow and the bush and bog harrow proved more effective for pasture pitting from the standpoint of storage capacity than either the lister or the subsoiler. (Blecker-Ariz)
W68-00725

EFFECTS OF IRRIGATION MANAGEMENT ON CHEMICAL COMPOSITION O SOYBEANS IN THE SAN JOAQUIN VALLEY, California University, Davis; U. S. Department of Agriculture, Agr Research Serv, Crops Research Div, Brawley, California. R. J. Miller, and B. H. Beard. Calif Agr, pp 8-10, Sept 1967. 3 p, 2 tab, 5 graph.

Descriptors: *Chemical analysis, *Irrigation effects, Soil-water-plant relationships, *Soybeans, Oilseed crops, Proteins, Crop response, Salt tolerance, Water requirements, Bouyoucos blocks, Boron, Field capacity, Soil moisture, On-site tests,

Identifiers: San Joaquin Valley, California.

Investigations at the West Side Field Station in the San Joaquin Valley were initiated in 1966 to deter-

mine yield responses of three soybean varieties to three levels of irrigation and also to determine the effects of irrigation treatment on the oil and protein content of the soybeans. Three varieties of soybeans, Chippewa, Clark, and Wayne were planted in pre-irrigated fields and received three different irrigation treatments. Moisture readings obtained with gypsum blocks showed the Clark variety required more moisture. It also grew taller and had a larger leaf area than the other two. The Wayne variety appeared to be more responsive to Wayne variety appeared to be more responsive to irrigation treatment and produced more protein and oil per acre than the others at higher irrigation levels. Soil and water chemical analyses were conducted. Boron levels were found to be high and may have influenced yields. With higher levels of irrigation the value from the increase in percentage of protein was more than enough to offset the decrease in percentage of oil and accounted for more of the average gross value per acre. (Affleck-Ariz) W68-00733

WILD V LEBLANC (DRAINAGE SERVITUDE FOR RICE FIELDS).

191 So 2d 146-150 (Ct App La 1966).

Descriptors: *Drainage, *Louisiana, Irrigated land, *Drainage practices, Easements, Irrigation, Rice, Surface water, Water law, Ditches, Judicial decisions, Drainage systems, Irrigation ditches, *Prescriptive rights. Identifiers: *Upper estate, Lower estate, *Drainage

servitude, Servitudes, Natural drainage.

This is a suit by the owner of an upper tract to obtain recognition of a servitude of drainage through a ditch over lower continguous tract. Plaintiff and defendant were both engaged in the cultivation of rice. For over 30 years water drained from plaintiff's tract over defendant's tract by means of a 300foot ditch into a large drainage canal. The water thus draining was both natural rainfall and water pumped into plaintiff's fields for irrigation. The water did not run continuously through the ditch as plaintiff closed off the ditch to flood her rice fields for a part of each growing season. Defendant has filled in the ditch, and plaintiff seeks to have the ditch restored to its previous condition. The court found that since the plaintiff's use of the ditch was continuous, in spite of periodic interruptions of flow during growing seasons, for more than the ten year prescriptive period, therefore plaintiff had acquired a prescriptive right to drainage across de-fendant's tract. The court confined its determina-tion to water actually within the ditch, expressly ex-cepting any overflow from its decision. (Kirkconnell-Fla) W68-00780

ARCADIA-VERMILLION RICE IRRIGATION CO V BROUSSARD (PRESCRIPTIVE IRRIGA-TION SERVITUDE).

175 So 2d 856-863 (Ct App La 1965).

Descriptors: *Louisiana, *Prescriptive rights, Irrigation canals, Civil law, *Irrigation water, Judicial decisions, Water rights.

Identifiers: *Irrigation servitude, *Continuous ser-

Plaintiff brought an action against defendants seeking a judgment recognizing plaintiff as the owner of an irrigation servitude over lands owned by defendants, and enjoining defendants from interfering with plaintiff's use of a canal located on their lands. Plaintiff claimed that it has been in continuous and open adverse possession of the irrigation servitude for over thirty years, which exceeds the ten year statutory period for acquiring a servitude. The center of the dispute is the statutory requirement that the servitude be continuous over the statutory period. After an extensive survey of the law defining a continuous servitude, the court reversed the trial court's decision in holding that the servitude was continuous. Such servitudes are not simply natural occurrences, but may be created and constructed by man. The circumstance which characterizes a continuous servitude is that its exercise does survive the act of man; it does not cease the moment the act ceases; and the servitude continues to be exercised after the owner of the dominant estate ceases to occupy or be on the servient estate. Hence a gate in the canal in question would not defeat the element of continuity. (Patterson-Fla) W68-00801

TRANSFER RESTRICTIONS AND MISALLO-CATIONS OF IRRIGATION WATER, Utah St. Univ., Logan; Iowa St. Univ., Ames. For primary bibliographic entry see Field 06C.

For abstract, see . W68-00992

IMPACT OF LAND, WATER AND VEGETA-TION RESOURCES ON THE ECONOMY OF THE CATTLE BREEDERS OF A DESERT VIL-LAGE.

Central Arid Zone Research Institut, Jodhpur, In-

For primary bibliographic entry see Field 06G. For abstract, see . W68-01002

EFFECT OF SURFACE-APPLIED WHEAT STRAW ON SOIL WATER LOSSES BY SOLAR DISTILLATION,

US Dept of Agriculture, Akron, Colorado. R W Greh

Soil Sci Society Amer, Proc, Vol 30, pp 786-788, 1966, 3 p. 2 fig, 3 tab.

Descriptors: Soil moisture, *Soil water movement, *Subble mulching, *Evaporation control, Solar distillation, Water vapor, Fallowing.

Two experiments were conducted at Akron, Colorado to study the effect of low application rates of wheat straw on soil water evaporation losses. A solar distillation technique was used to condense water vapor from specific soil surface mulch treatments for subsequent measurement. Soil surface application of 1,120, 2,240 and 3,360 kg/ha of wheat straw, equivalent to 30, 60, and 90% soil surface coverage, reduced water losses from a wet soil surface by solar distillation 16, 33 and 49% respectively, for a 20-day period compared with no straw. In terms of water loss, 1.37, 0.46, and 0.41 cm was evaporated for the test period using the 0, 3,360 and 6,720 kg/ha straw treatments respectively. A surface application of 6,720 kg/ha or 180% soil coverage, reduced soil water loss only slightly more than did the 3,360 kg/ha application. The results suggest part of the mechanism by which more soil water is conserved under stubble mulch summer fallow than with clean fallow. Since wheat is grown in the arid parts of the world, the cultural techniques studied in the article could be applied to these areas. (Blecker-Ariz) W68-01004

STUDY OF WATER EVAPORATION FROM

SOILS, U.S.S.R. Institute of Physical Chemistry. For primary bibliographic entry see Field 02D. For abstract, see . W68-01006

04. WATER QUANTITY MANAGEMENT AND CONTROL

4A. Control of Water on THE Surface

ANALYTICAL AND COMPUTER SOLUTIONS OF TRANSIENT WATER TO DRAINAGE OF SLOPING LAND, TABLES FOR

The Ohio Agricultural Research and Development Center and the Ohio State University, Columbus.

Water Resources Res, Vol 4, No 3, pp 573-579, June 1968, 7 p, 8 fig, 21 ref.

Descriptors: *Drainage, Analog computers, *Drawdown, Water management (Applied), *Drainage systems, Land management, *Porous media, Non-uniform flow, Mathematical studies, Laplaces equation, Stokes law, *Tile drains. Identifiers: Boussinesq equation, Time-variable end conditions, Transient water tables.

Transient water table drawdown in sloping land lying between parallel, open ditches was obtained by solving Boussinesq's equation on the analog computer and by analytical methods for zero and time-variable end conditions at the ditches. Comparison of the results with observations made on a viscous flow model indicated that the solution with time-variable end conditions described the flow region better than the solution with zero end solutions. (Knapp-USGS) W68-00666

A MATHEMATICAL MODEL FOR SIMULATING THE HYDROLOGIC RESPONSE OF A WATERSHED,

Purdue Univ., Lafayette, Ind. L. F. Huggins, and E. J. Monke. Water Resources Res, Vol 4, No 3, pp 529-539, June 1968. 11 p, 9 fig, 1 tab, 14 ref.

Descriptors: *Watersheds (Basins), *Mathematical models, *Surface runoff, Hydrographs, Storms. Identifiers: Physical hydrology.

In a general study to improve the accuracy and re-liability of predicted hydrographs, a mathematical model was developed to simulate the surface runoff from watersheds. Based upon the integration of physical hydrology concepts into quantitative rela-tionships, the model avoids the use of lumped parameters by delineating the watershed as a grid of small, independent elements. Very complex combinations of watershed and storm conditions can be studied because of the resultant freedom from fundamental assumptions regarding the form of the system equations and from the permissible small areal resolution of the model. When the model was applied to 2 very small watersheds, the need was seen for additional research to better define the relationships for surface runoff and infiltration to improve the reliability of the simulated runoff hydrographs. (Llaverias-USGS) W68-00668

A STUDY OF THE DRAINAGE OF IRRIGATED

A STUDY OF THE DRAINAGE OF IRRIGATED SAND DUNES USING AN ELECTRICAL RE-SISTANCE ANALOGUE, Australia, New South Wales Water Conservation and Irrig. Comm; University of Melbourne, Australia, Agricultural Engineering Department. R. G. Mein, and A. K. Turner. J of Hydrol (Amsterdam), Vol 6, No 1, pp 1-14, 12n 1048, 14 n. 9 fig.

Jan 1968. 14 p, 9 fig.

Descriptors: *Irrigation effects, *Dunes, *Drainage engineering, *Sands, *Analog models, *Resistivity, Electrical resistance, Flow nets, Base flow, Permeability, Stratigraphy, Resistance networks. Identifiers: New South Wales, Australia, Steady

The development of irrigated horticulture on large sand dunes in the Coleambally and Murrumbidgee Irrigation areas of New South Wales could cause drainage problems on the lower faces of the dunes because of their stratigraphic feature. The two types of dunes under study were the source bordering dune and the cudge sandhill dune. The electrical resistance board lends itself to a study of steady state drainage in large sand dunes because of the ease with which length and distance scales can be manipulated. Networks comprising fixed and/or variable resistors were used to determine flow nets for various boundary conditions. (Blecker-Ariz) W68-00711

PIEDMONT COTTON MILLS, INC V GENERAL WAREHOUSE NO 2 (DAMAGES FOR STREAM DIVERSION).

State of Georgia.

22 Ga 164, 149 SE 2d 72-79 (1966).

Descriptors: *Alteration of flow, *Georgia, *Water injury, *Diversion, Artificial watercourses, Ditches, Judicial decisions, Floods, Drainage, Surface runoff, Watercourses (Legal), Erosion, Relative rights, Water law, Flood waters.
Identifiers: *Injunction, Damages (Legal aspects).

This was an action by property owners for damages and injunctive relief based on alleged diversion of a stream from its channel resulting in flooding of plaintiff's property. Defendant diverted a stream from its natural course across plaintiff's and defen-dant's land into a ditch along the boundary between plaintiff's and defendant's land. Before the diversion, the stream carried off all excess water during rains. Since the diversion by the defendant, the plaintiff's land is flooded during rains, and the excess water thus cast upon plaintiff's land is causing erosion of plaintiff's boundary, underculling plaintiff's road, and leaving debris on plaintiff's land after rains. The court held that plaintiff's complaint stated a cause of action. The proper measure of damages was the dimunition in the market value of plaintiff's property plus reasonable and necessary expense incurred in minimizing plaintiff's property damage, compensatory and punitive damages and a permanent injunction were awarded against defendant. (Kirkconnell-Fla)
W68-00744

SURFACE WATER IN INDIANA,

Indiana University, Bloomington.

Thomas L. Shaffer. Ind L J, Vol 39, No 1, pp 69-108, Fall 1963. 40 p, 231 ref.

Descriptors: *Indiana, *Surface waters, Surface drainage, Hydrologic cycle, Repulsion (Legal aspects), Riddance (Legal aspects), Surface runoff, Legal aspects, Judicial decisions, Water resources development, Water law, Civil law.

In determining whether or not a particular body of water is to be classified as surface water the Indiana courts have looked at one or more of several characteristics usually attributed to surface water, but have not established any really reliable test. Surface waters belong to an upper property owner as soon as they flow or fall on his land and he must either keep them there or permit them to flow off without artificial interference, unless he can channel them into a natural watercourse within the boundaries of his property or he has an easement or prescriptive right through a lower owner's proper-The common enemy rule is available only to lower property owners and permits them to repel surface waters flowing onto their lands, but a strict application of this rule is not made in all cases. There is a need to more fully develop surface water use and this should be done by the protection of reasonable individual efforts, narrow application of the common enemy rule, recognition of the value of private common efforts, and an expansion of the doctrine of usefulness. (Smith-Fla) W68-00749

Field 04-WATER QUANTITY MANAGEMENT AND CONTROL

Group 4A—Control of Water on the Surface

DEKEL V VANN (NATURAL FLOW OF SUR-FACE WATERS). 279 Ala 153, 182 So 2d 885-889 (1966).

Descriptors: *Alabama, *Surface runoff, *Repulsion (Legal aspects), Slopes, Overland flow, Legal aspects, Judicial decisions, Cities. Identifiers: *Civil law rule.

This was an action by property owners for a mandatory injunction requiring the adjoining property owner to remove a wall from the dividing line between the properties. The plaintiffs claim that the wall obstructs the natural flow of surface water across their property. The Alabama Supreme Court held that lands outside a municipality are subject to the civil law rule that requires the lower land to receive the water that falls on and flows from the higher land. In incorporated towns or cities the common enemy rule applies, and the lower owner could build such a wall to prevent the flow of water on his land from the land of another. The mere fact that the property in question is located in a subdivision and is so developed as to have the attributes of urban property is not sufficient to permit the application of the common enemy rule. Unless the property is in an incorporated city or town, the civil law rule must be applied. (Smith-Fla) W68-00767

SMITH V BOARD OF COUNTY RD COMM'RS (DAMAGE BY IMPOUNDED WATERS).

5 Mich App 370; 146 N W 2d 702 (1966).

Descriptors: *Michigan, *Reservoirs, *Impounded waters, *Water injury, Remedies, Roads, Judicial decisions, Surface waters, Culverts, Flooding, Precipitation, Obstruction to flow, Water law, Surface waters, Culverts, Flooding, Precipitation, Control of the Cont face runoff, Embankments. Identifiers: *Act of God.

This was an action for personal injuries and property damage caused by water which escaped from an artificial reservoir created by defendant. For many years water had drained into a basin which was sur-rounded on three sides by roads. Water escaped from this basin through an 18 in. culvert under Ranger Road and by flowing over the top of this road. Defendant raised the level of Ranger Road several feet and replaced the 18 in. culvert with a 24 in. culvert. The construction prevented excess 24 in curvert. The construction prevented excess water from excaping over the top of Ranger Road. In May 1959, after heavy rains, one of the other roads surrounding the basin gave way, permitting the impounded water to rush onto plaintiff's land, destroying his house and causing personal injuries. Defendant set up the defense that the torrential rains were an act of God. One who collects water in an artificial reservoir is liable for damages caused by the escaped water trespassing onto the land of other parties. Act of God is a valid defense to this claim. The jury verdict for defendant was proper. (Kirkconnell-Fla) W68-00773

DEWITT V DEWITT (SURFACE DRAINAGE).

147 N W 2d 32-36 (Iowa 1966).

Descriptors: *Iowa, *Surface runoff, Drainage water, Obstruction to flow, Judicial decisions, *Remedies, Riddance (Legal aspects). Identifiers: *Dominant estate, *Servient estate.

Plaintiff and defendant owned adjoining farmland, the natural flow of surface water running from plaintiff's property onto the defendant's. Defendant's farming operations built up the ground at the fence line so that water ceased to seep over in its natural course. The trial court found the plaintiff's land to be dorminant and the defendant's servient, stating that relative elevation and not general movement of flood waters was controlling. The trial court held the applicable law to be that the servient estate is bound to take the natural flow of surface water from the dominant estate, unless some action of the dominant owner materially and unduly increases the quantity of water and thereby damages the servient estate. The trial court then issued an injunction against the defendant requiring him to level off the ridge at the property line. The lowa Supreme Court affirmed the trial court in the instant case, holding, inter alia, that a statute providing for a drainage ditch when two or more landowners so desire did not offer plaintiff an adequate remedy at law. Therefore, an injunction was the proper form of relief. (Patterson-Fla) W68-00774

MELLO V LEPISTO (SURFACE DRAINAGE).

77 111 App 2d 399, 222 NE 2d 543-545 (1966).

Descriptors: *Illinois, *Surface runoff, Repulsion (Legal aspects), Surface drainage, Reasonable use, Landfills, Land forming, Drainage, Legal aspects, Judicial decisions, Civil law.

Plaintiffs seek to recover the cost of construction of a retaining wall built by them to prevent water from defendants' adjoining land from running onto theirs. The court held that Illinois does not follow the common enemy doctrine which permits a landowner to repel drainage waters in any manner he chooses. Instead, they follow the civil law rule which requires the servient lands to accept all waters naturally following from dominant lands. There is no reasonable use exception to this rule in the case of urban lands. There was held to be no cause of action in this case because there was testimony that both properties had been filled and there was no allegation or testimony concerning the course of natural drainage. (Smith-Fla)

EIGHTH REPORT.

Iowa Natural Resources Council (1962-1964).

Eighth Rep, pp 1-59, Dec 1964. 60 p, 4 fig, 4 plate,

Descriptors: *Iowa, *Water resources development, Administration, Legislation, Local governments, Federal government, State governments, Natural resources, Permits, Flood control, Administrative agencies, Coordination.

This article covers the whole range of governmental water-connected programs in lowa during the biennium beginning July 1, 1962 and ending June 30, 1964. State participation in water resources and flood control programs has included coordinated planning, investigation of water problems, flood control and damage reductions, and collection of basic data. State coordination with federal programs has been in the areas of federal flood control and navigation programs, flash flood warning program, watershed programs, and flood plain information studies. Major responsibility for certain flood control programs rest with local interests, and the state has coordinated its programs with these interests in the areas of flood plain construction, regulation and zoning, flood control works and floodways, and mill dams. Water resources conservation and control activities have been concerned with the administration of the permit system and the resolution of problems associated with the system. Due to the recent discovery of oil in Iowa a new law was passed allowing the Resources Council to encourage and regu-late exploration by a permit system. Proposed legislation would remove the burden of proof of reasonableness of the Resources Council's action from them or appeal from their decisions. (Smith-W68-00778

WINTER V CAIN (SURFACE DRAINAGE). 187 So 2d 237-243 (Ala 1966).

Descriptors: *Alabama, Logal governments, State governments, *Surface drainage, Drainage, Drainage water, Cities, *Surface runoff, Flow, Real

property, Easement, Zoning, Water law, Legal aspects, Legislation.

The defendant, in violation of a city ordinance, erected a wall on his property which prevented the drainage of water from the plaintiff's adjoining land. The court held that the ordinance forbidding erection of a wall without adequate openings to permit the flow of surface drainage was in conflict with the policy of the state governing urban property rights with respect to surface waters. Under the state constitution, an ordinance inconsistent with state laws is invalid and the plaintiff has no cause of action under the ordinance. (Horner-Fla) W68-00782

THE TREND IN WATER LAW DEVELOPMENT (SURFACE WATER IN MICHIGAN),

Univ. of Michigan Law School. For primary bibliographic entry see Field 06E. For abstract, see. W68-00787

O'DELL V MCKENZIE (OBSTRUCTION TO NATURAL STREAM FLOW).

145 S E 2d 388-392 W Va 1965).

Descriptors: *West Virginia, *Obstruction to glow, Riparian rights, Flood damage, Floods, Legal aspects, Judicial decisions.

An upper riparian owner sued a lower riparian owner and his lessee for damages to his property by flooding, caused by casting of waste into the stream by the defendants, damming it up. The West Virginia court ruled that no person may obstruct or divert the natural flow of a stream of water to the injury of a riparian owner above or below. Where the lessor and the lessee of land act in a common purpose, the lessor permitting the lessee to erect structures which cause damage to the land of another, they are jointly liable for the resulting damage. Where the injury is temporary the measure of damages is the cost of repair, reimbursement of expenses directly occasioned by the injury, and compensation for the loss of use or rent. (Smith-Fla) W68-00798

BALDWIN PROCESSING CO V GEORGIA POWER CO (LIABILITY OF OWNER OF HYDROELECTRIC DAM FOR FLOODING). 112 Ga App 92, 143 S E 2d 761-769 (1965).

Descriptors: *Georgia, Dams, Water levels, Hydroelectric plants, Flood control, Flood damage, Reservoir operation, *Reservoir storage, Water injury, Storage, Safety, Discharge (Water), Excessive precipitation, Legal aspects, Judicial decisions.

Plaintiff sued the owner of a hydroelectric dam for damages to his property caused by high waters. The Georgia Court of Appeals held that there is no duty on the part of the owner of a hydroelectric dam to operate the dam as a flood control mechanism. Any claim of a lower riparian owner against an upper riparian dam owner must be based on the negligent release of excessive water. Such an action cannot be based upon the negligent storing, unless the storing caused or forced the release of excessive water such as a break in the dam itself or release of excessive water to prevent damage to the dam. A dam owner may maintain his reservoir at any level so long as the storing of excessive water does not create an emergency, causing or necessitating the dumping of such water to the injury of the lower owner. (Smith-Fla) W68-00799

COMMISSIONERS OF MCGEE CREEK LEVEE AND DRAINAGE DISTRICT V DENN (DRAINAGE ASSESSMENTS). 58 111 App 2d 466, 207 N E 2d 313-320 (1965). DENNIS

Descriptors: *Illinois, Water districts, *Drainage water, Surface runoff, Judicial decisions.

On appeal by certain objectors from an order of a lower court confirming an annual drainage main-tenance assessment roll after jury trial, the court upheld, inter alia, the refusal of the lower court to give a jury instruction stating that every objector was entitled to enjoy his property with such natural advantages as are derived from its situation in a water district. The instruction further stated that such objector was under no obligation to assist the owner of a servient estate of lower elevation to get rid of water flowing onto such lower land. The court found that this instruction ignored a provision of the Illinois Code giving a right to landowners within a water district to exercise private rights of drainage except insofar as the drainage system of the district may vary from or be inconsistent with natural drainage. (Patterson-Fla) W68-00802

PRELIMINARY REPORT OF THE WATER RESOURCES OF THE HILO-PUNA AREA, HAWAII,

U. S. Geological Survey. Dan A. Davis, and George Yamanaga. Hawaii Div of Water and Land Develop Circ C45, 38 p, Apr 1968. 13 fig, 6 tab, 11 ref.

Descriptors: *Water resources, *Hawaii, *Groundwater, *Hydrologic data, Aquifers, Basalts, Water quality, Water levels, Hydrogeology, Data collections, Springs, Municipal water, Specific capacity, Runoff, *Streamflow, Duration curves, Hydrographs, Discharge (Water), Gaging stations, Climbia data of the control of the cont matic data.

Identifiers: *Hilo-Puna area, Hawaii, Preliminary water-resource report, Test holes, Water availabili-

The hydrology of the Hilo-Puna area on the east coast of Hawaii is outlined, and the quality and quantity of water available for development are summarized. The area includes about 950 sq mi of the slopes of Mauna Loa and Kilauea and is underlain by highly permeable uneroded lava flows. Average rainfall is 120 in. per yr, most of which in-filtrates. The largest stream discharges over 175 mgd into Hilo Bay. Hilo's water supply of 3-4 mgd is mostly from stream diversions, springs, and tunnels in stream basins. Thin bodies of perched groundwater are developed by several tunnels on the slopes of Mauna Loa. The perched water flow averages less than 50 mgd, fluctuates widely with rainfall, and sometimes is dry during drought. The basal groundwater discharge at the shore is several hundred mgd. The basal aquifer is tapped by 23 drilled wells and a shaft, which withdraw 15-20 mgd mostly for industrial use. Flor-duration curves are given for the Wailuku River and the Waiakea stream. Climatic data are summarized graphically and in tables. (Knapp-USGS) W68-00821

STOCHASTIC MODELS FOR HYDROLOGY,

Cornell Univ., Ithaca, N. Y. N. U. Prabhu.

Cornell University Water Resources and Marine Sciences Center, Technical Report No 10, Aug

Descriptors: *Approximation, Distribution, Wet and dry periods, Statistical equilibrium. Identifiers: *Large-time approximation, Location and scale parameters.

'Large-time' approximations are obtained for the various distributions of interest in two stochastic models for water reservoir systems (dams). These approximations are based mainly on three standard probability distributions: (1) normal; (2) truncated normal; and (3) stable distribution with index 1/2. The quantities considered are the wet and dry periods in the dam and the water level at any given time. In particular when the mean input rate exceeds the demand rate it is known that the storage

processes do not reach statistical equilibrium, but results are established to show that limiting distributions exist for these processes with a proper choice of location and scale parameters (depend-ing on time). These results add to the understanding of stochastic phenomena associated with water reservoir systems. (Author) W68-00897

FLOOD STAGES AND DISCHARGES FOR SMALL DRAINAGE AREAS IN NEW MEXICO, U. S. Geological Survey, Albuquerque, N. Mex. Arthur G. Scott, and Ralph W. Clement.

U. S. Geol. Surv. open-file rep, 165 p, Mar 1968. 2

Descriptors: New Mexico, *Floods, *Small watersheds, Stage-discharge relations, Surface waters, Discharge (Water), Streams, Hydrologic data, Discharge measurement, *Peak discharge, Streamflow, Gaging stations, Flooding, Identifiers: Flood peaks, *Annual flood, *Crest-stage stations, *Annual peak stage, Small drainage areas, Peak stages, High flow, Flood data.

Available peak-stage and discharge data for each water yr are given for 158 stations throughout New Mexico for the period ending Sept 1966. Most of the data have been collected since July 1951 from the operation of crest-stage gaging stations by the U. S. Geological Survey in cooperation with the New Mexico State Highway Commission. Some additional data for flood peaks that occurred before 1951 also are included where available. The purpose of the program is to provide information on the magnitude, volume, and frequency of floods, primarily in drainage areas of 10 sq mi or less, to aid in the design of highway drainage structures. Drainage areas of the basins, for which data are reported, range from less than 1 sq mi to 4,350 sq mi. However, 106 are less than 50 sq mi and only 4 are more than 1,000 sq mi. (Leonard-USGS) W 68-00923

DIFFUSED SURFACE WATER AND RIPARIAN RIGHTS: LEGAL DOCTRINES IN CONFLICT, Louisville Univ., Ky

William F. Dolson.
Wis L Rev, Vol 1966, No 1, pp 58-120, Winter 1966. 63 p, 256 ref.

Descriptors: *Surface runoff, *Wisconsin, *Relative rights, Ditches, Water law, Water utilization, Judicial decisiions, Riparian rights, Drainage ditches, Regulation, Impounded waters, Surface drainage, Water permits, Surface-groundwater relationships, Overland flow, Administrative agencies Langlation. cies, Legislation.
Identifiers: *Model Water Use Act.

Increased water needs have created an interest in the utilization of diffused surface water as a source of supply. Generally diffused surface water is considered capable of complete ownership by the owner of the land on which it is found. Rights of adjoining landowners to receive continued flow and to impound diffused surface water are examined to impound diffused surface water are examined. Prescriptive rights to the use of surface water in private drainage ditches depend on whether the watercourse is of a temporary or permanent nature. The right to withdraw water from public ditches is regulated by statute in Wisconsin. The law of diffused surface water has evolved as a separate doction from that of rights rights. This dichotomy. trine from that of riparian rights. This dichotomy ignores the hydrologic cycle and thus creates a problem in correlation of the rights of riparians and users of diffused surface water. Legislative attempts to define the rights of riparians vis-a-vis the rights of users of diffuse surface waters are ex-amined. The Model Water Use Act is noted. Legislation to clarify water rights among the various users of water is suggested. (Kirkconnell-Fla) W68-00929

SURFACE WATER RIGHTS IN ALABAMA, Alabama Univ., University, Ala. Kenneth T. Fuller, and Howard H. Galloway.

Ala L Rev, Vol 10, No 1, pp 154-169, Fall 1957. 16 p. 33 ref.

Descriptors: *Alabama, Drainage water, *Surface runoff, Surface drainage, Drainage, *Surface waters, Easements, *Civil law, Railroads. Identifiers: Superior proprietor, Inferior proprietor.

Alabama adopted a modified Civil Law Rule for surface water in rural areas, which states that, although generally one cannot interfere with surface water runoff, the owner of a superior heritage can ditch his land for drainage as long as he only concentrates the flow of water that would have flowed onto the inferior heritage anyway. This rule has been inconsistently applied, but now seems firmly entrenched. An exception, based on dicta in several of the rural cases, is recognized for city lots where the lower proprietor in developing his lot obstructs the flow of surface water. However, it has been held that an upper owner cannot collect surface water in a channel and cast it down upon his lower neighbor. This points up a difference between rural and urban land. The courts have apbetween rural and urban land. The courts have applied the strict Civil Law Rule against railroads. It is concluded that the Civil Law Rule, adapted to an agrarian topography, will be modified as Alabama continues to develop as an urban and industrial state. (Williams-Fla) W68-00930

FLORIDA'S FRESH WATER LAKES,

Florida Univ., Gainesville. Ney C. Landrum.

Public Administration Clearing Service, No 33, pp 1-37, 1959. 38 p.

Descriptors: *Florida, Lakes, Lake beds, Ownership of beds, State government, Navigable waters, Non-navigable waters, Riparian rights, *Water resources development, Legal aspects, Legislation. Identifiers: Public trust doctrine.

When Florida was ceded to the United States by Spain, the territory was surveyed and all lakes then considered to be navigable were meandered. About 190 lakes were meandered in the survey, but many more lakes which were in fact navigable were er-roneously omitted. The State of Florida, through the Trustees of the Internal Improvement Fund, holds title to the submerged bottoms of all navigable lakes in trust for the public. The Trustees have adhered to the concept that they only hold meandered lakes in trust as navigable lakes, and the remainder of lakes not meandered but navigable have been conveyed to private owners. The author nave been conveyed to private owners. The author concludes that the Trustees have become an agency for the disposal of lake bottoms and have done no lake management in the public interest, which was originally intended to be dominant. All navigable lakes, whether meandered or not, should be claimed by the state for public use and enjoyment, rights of access and access points should be established, and a more broad and definite policy of lake management should be implemented. (Smith-Fla) W68-00931

4B. Groundwater Management

WATER IN ORANGE COUNTY, FLORIDA, U. S. Geological Survey, Tallahasee, Florida. For primary bibliographic entry see Field 03B. For abstract, see W68-00655

THE STUDY OF LOCAL WATERS IN THE DESERTS OF THE USSR, Institute of Geography, Moscow, and Desert In-

stitute, Ashkhabad.

V. N. Kunin. Soviet Geogr Rev and Transl, Vol 9, No 6, pp 469-488, June 1968. 20 p, 67 ref.

Descriptors: *Water supply, Groundwater, Artesian water, Water management (Applied), *Water resources development, Irrigation, *Deserts, *Sur-

Field 04-WATER QUANTITY MANAGEMENT AND CONTROL

Group 4B—Groundwater Management

face-groundwater relationships, Irrigation water, Runoff, Recharge, Water storage. Identifiers: *USSR, Central Asian Deserts, Takyrs.

The local freshwater sources of the deserts of the USSR are reviewed to determine suitability for stock, domestic, and industrial uses. One of the most promising sources is the collection of runoff from claypans (takyrs) for artificial recharge of permeable beds. This has been used for hundreds of years for stock water supplies and works with water tables as deep as 30-35 m in the Kara Kum. A flock of 1,000 sheep requires 50 to 100 sq km of grazing land which can be supplied with water by a claypan watershed of 0.3 sq km or less. Artificial catchments are even more effective. Groundwater in much of the desert area is too saline for stock use. Fresh groundwater lies over saline water in lenses in the Kara Kum and other deserts and provides only small supplies locally although the re-gional total volume of water is large. Use of the proper well arrays helps prevent saline intrusion. Artesian waters are usually not fresh enough for stock use, and often even when fresh are not the most economical source. (Knapp-USGS) W68-00664

THE ASSAULT ON SALT IN THE PECOS,

Agricultural Economist, Amarillo, Texas. George L. Loomis.

Reclamation Era, Vol 52, No 2, pp 37-39, May 1966. 3 p, 3 photo.

Descriptors: *Water quality, *Desalination, *Pumping, *Salts, *Evaporation, Irrigation water, Saline water, Brines, Aquifers, Interagenc cooperation, Sodium chloride, Leakage, Disposal. Identifiers: *Pecos River Valley. Interagency

For thirty to forty years the irrigation farmers in west Texas have not enjoyed an abundance of fresh water from the Pecos River because of a malady a few miles north at Malaga Bend, New Mexico. An aquifer there has been discharging up to 370 tons of concentrated sodium chloride brine daily into the river. The dissolved brine rises through sand, silt and clay from depths of about 200 feet. In 1958, a plan was developed to lower the head of the brine a pian was developed to lower the head of the brine aquifer below river level by pumping. The brine was pumped into a natural surface depression (Northeast Depression) where the water would evaporate leaving a solid salt residue. Samples from the upper and lower ends of the Malaga Bend indicate that the gain in chloride in the Pecos River was reduced to about 100 targeties and of the Malaga Bend indicate that the gain in chloride in the Pecos River was reduced to about 100 tons per day. (Blecker-Ariz) W68-00693

ECONOMIC CONTROL OF GROUNDWATER

RESERVES, Missouri Univ., Department of Agricultural Economics.

For primary bibliographic entry see Field 06D. For abstract, see. W68-00704

RESUME OF GROUND WATER HYDROLOGY IN THE SOUTHERN SAN JOAQUIN VALLEY, HydroDevelopment Inc., Bakersfield, California. John C. Manning. Amer Water Works J, Vol 59, No 12, pp 1513-1526, Dec 1967. 14 p, 9 fig, 1 tab, 15 ref.

Descriptors: *Groundwater basins, Groundwater Descriptors: *Groundwater basins, Groundwater mining, Geology, *Safe yield, *Hydrogeology, Runoff, Water management (Applied), *Overdraft, Discharge (Water), *Groundwater movement, *Hydrology, History, Surface waters, Water quality, *Irrigation water, Water chemistry, Surfacegroundwater relationships, Water supply. Identifiers: San Joaquin Valley, California, Irrigation agriculture

tion agriculture.

The article summarizes conditions in the southern San Joaquin Valley, California, which have caused a large overdraft from the ground water supply and

suggest possible changes that may occur within the ground water basin in the future. Some of the areas under study were the developmental history of the valley, use of ground water, regional geology, surface and ground water hydrology, ground water quality, natural discharge, ground-water overdraft, safe yield and computing overdraft. The future will bring changes in water supply and patterns of land and water use that may drastically alter groundwater regimen in the southern San Joaquin Valley. (Blecker-Ariz) W68-00722

WATER UNDER THE SAHARA,

Robert P. Ambroggi. Sci Amer, Vol 214, No 5, pp 21-29, May 1966. 9 p, 6 fig, 1 map, 3 photo.

Descriptors: *Water resources development, *Groundwater basins, *Aquifers, *Artesian wells, *Arid lands, Confined water, Recharge, Subsurface waters

Identifiers: *Sahara, Erg. Oases.

Thirteen countries of 148 million inhabitants share the vast territory of the Sahara and the deprivation its name implies. Below the desert sands in waterbearing rock formations are huge quantities of water to sustain human settlement, pasturage for livestock and, in many places now barren, productive agriculture. Good soils are available and Saharan oil can supply energy needed to pump water. Artesian wells have been drilled and the rate and direction of water movement in artesian aquifers has been determined for the whole area. Groundwater is to be found mainly in seven major basins, each virtually a closed hydrologic system. Aquifers are recharged to a considerable extent by rainfall on the periphery of the desert. With a capacity of some 15,000,000 million cu m of groundwater, total recharge of these basins is probably 4000 million cu m a year. Present level of consumption appears to be about 2000 million cu m a year. Sound agricultural and irrigation practices should be introduced before developing new supplies of groundwater or extending oases. Water problems of the Sahara must be dealt with on a national/international basis using modern concepts of development to make its groundwater a resource of benefit to all. (Blecker-Ariz) W68-00729

OPERATING A LIMESTONE AQUIFER AS A RESERVOIR FOR A WATER SUPPLY SYSTEM, TAHAL, Water Planning for Israel, Tel Aviv Y. Harpaz, and J. Schwarz.

Bull of the Int Ass of Sci Hydrol, Vol 12, No 1, pp 78-90, March 1967. 13 p, 9 fig.

Descriptors: Water resources development, *Aquifer characteristics, Physical properties, *Analog models, *Reservoir storage, Limestones, Hydrogeology, Transmissivity, Electrical equipment, Pumping, Economic feasibility, *Draftstorage curves, Groundwater recharge, Hydraulic conductivity, Water supply, *Hydrologic equation, Storage canacity. Storage capacity. Identifiers: Israel

Lack of water resources and unfavorable distribution of arable land characterize Israel's water problems. The principal factors involved in the planning of underground storage schemes and a study of the limestone-dolomite aquifer and its operational aspects were discussed. Investigations were carried out to determine the physical properties and behavior of the aquifer. An electric analog model was developed by which hydraulic responses to recharge and pumpage were obtained. Criteria for optimal operation of the aquifer were set up and various planning and operational alternatives were tested in accordance with the criteria. An optimization analysis for the operation of the aquifer was developed and was shown by way of a practical example. (Blecker-Ariz) W68-00730

INTEGRATED OPERATION OF MULTIPUR-POSE RESERVOIRS FOR IRRIGATION, FLOOD CONTROL, AND OTHER PURPOSES ON BUREAU OF RECLAMATION PROJECTS, Bureau of Reclamation, Washington, D.C. For primary bibliographic entry see Field 06D For abstract, see. W68-00734

A REGIONAL INTERBASIN GROUNDWATER SYSTEM IN THE WHITE RIVER AREA, SOUTHEASTERN NEVADA, U. S. Geological Survey, Water Resources Divi-sion, Carson City, Nevada.

Thomas E. Eakin.

Water Resources Res, Vol 2, No 2, pp 251-271, 1966. 21 p, 6 fig, 6 tab, 28 ref.

Descriptors: *Hydrogeology, *Groundwater basins, *Precipitation, *Recharge, *Watersheds (Divides), *Watersheds (Basins), Carbonate rocks, Hydraulic properties, Nevada, Groundwater recharge, Rock properties, Discharge (Water), Springs, Hydraulic gradient, Groundwater move-ment, Chemical analysis.

The region discussed includes the area within drainage divides of six valleys drained by the White River. The regional groundwater system included both rocks and groundwaters of the defined area.
Rocks provided the framework in which groundwater occurred and moved. Several stratigraphic units were discussed and grouped broadly on the basis of apparent gross hydraulic properties. Fracture and solution openings in Paleozoic carbonate rocks locally store and transmit substantial quanti-ties of groundwater. Precipitation provided the ties of groundwater. Precipitation provided the principle source of water for recharge to the regional groundwater system. The principle natural discharge of groundwater was from the three groups of springs in the White River, Pahranagat and Upper Moapa Valleys. Estimates of recharge to and discharge from the regional system were 104,000 acre-feet and 103,000 acre-feet a year respectively. The chemical character of groundwater in part reflected an interaction between water and rocks through which it passed. Identification of the regional system was provisional in that it was based largely on indirect methods and limited data. (Blecker-Ariz) W68-00740

WATER RIGHTS - SPANISH LAND GRANTS - APPURTENANT IRRIGATION RIGHTS. So. Methodist U, Dallas, Texas.

Southwestern L J, Vol 17, No 1, pp 193-198, Mar 1963. 6 p, 34 ref.

Descriptors: Irrigable land, Irrigation, Appropriation, Judicial decisions, Legal aspects, Public rights, Riparian land, Riparian rights, Water law, *Water rights, Land classification, Priorities, Prior appropriation, *Texas, Rio Grande, Foreign countries, Mexico.

A case comment on the Texas Supreme Court decision in Valmont Plantations v State, 355 S W 2d 502 (1962), is presented. Dictum in previous cases had found irrigation rights in Spanish land grant lands similar to common-law riparian rights. It had been settled law in Texas that rights of those holding title from prior sovereigns are controlled by laws in effect when the grants were made. Spanish law did not recognize riparian rights of common law. The Supreme Court of Texas held that irrigation rights were not appurtenant to original Spanish land grants unless expressly included. It is con-cluded that this decision is based on a correct analysis of Spanish law. The previous cases had created some inequities, which it is felt would be cleared up by the decision in the Valmont Plantations case. (Pfeiffer-Fla) W68-00745

BILLERMAN V BASIAK (WELL EASEMENT). 47 N J 226; 220 A 2d 105-106 (N J 1966).

Descriptors: *Wells, Drilling, *Easements, Legal aspects, Boundaries (Property), Water rights, Judicial decisions, *New Jersey.

Plaintiffs needed a new well and had one drilled about a hundred feet behind their old well at the rear of their property. Later they learned this was not on their property, but on defendants', with whom they could reach no adjustment when defendants threatened to terminate their use of the well, plaintiffs instituted this suit for injunctive relief. The trial court issued the injunction on the bases of defendants' having acquired an easement for the well. The reasons for the court's finding an easement were: (1) plaintiffs mistakingly believed they owned the land and were not culpably negligent in doing so; (2) defendants had constructive knowledge that the well was being dug and said nothing. Upon appeal, the Supreme Court of New Jersey upheld the finding of an easement, but nar-rowed the scope of plaintiffs' rights in the well on defendants' property. The supreme court conditioned the easement on defendants' receiving the following benefits and rights: (1) reasonable payment for the easement; (2) right to terminate the easement if it interferes with their use or a sale; (3) right to tie into the well without charge. (Harriett-W68-00783

GROUND-WATER MANAGEMENT FOR THE NATION'S FUTURE - OPTIMUM CONJUNCTIVE OPERATION OF GROUND-WATER BASINS,

California Dept of Water Resources. Robert Y. D. Chun, Louis R. Mitchell, and Kiyoshi

W. Mido. Amer Soc Civil Eng Proc, Vol 90, No HY 4, pp 79-95, July 1964. 17 p, 5 fig, 3 ref.

Descriptors: Aquifers, *Conjunctive use, Digital computers, Distribution systems, *Economic efficiency, Future planning (Projected), *Ground-water basins, Groundwater recharge, Optimum development plans, Pumped storage, Pumping,
*Surface-groundwater relationships, *Water management (Applied), Hydrologic data, Artificial

recharge. Identifiers: Daily, Hourly, Present value.

An investigation of the Coastal Plain of Los Angeles County was made, in order to achieve the optimum coordinated operation of surface and ground water supplies and facilities. The objectives were to meet the growing and fluctuating water demands, maximize conservation of local water, and minimize sea-water intrusion. The study period was 1964 to 1990. Alternative plans of operation, each making optimum use of existing facilities, were studied. The four variables in each plan were: (1) the pattern of extractions; (2) the methods of preventing sea-water intrusion; (3) a spreading schedule; and (4) an extraction schedule. Monthly, daily and hourly demands were analyzed to establish short term peaking requirements. Cost equations were formulated and differentiated with respect to booster flow capacity in order to determine the most economical combination of pumping and in order to determine the most economical combination of pumping and storage facilities. The plan with the minimum present value of costs yielded the greatest benefit/cost rates, since all plans were formulated to satisfy identical physical requirements. (Gysi-Cornell) W68-00875

FUTURE DEVELOPMENT OF THE GROUND-WATER RESOURCE IN THE LOWER GREAT MIAMI RIVER VALLEY, OHIO-PROBLEMS AND ALTERNATIVE SOLUTIONS,

U S Geological Survey. Andrew M. Spieker. U S Geol Surv Prof Pap 605-D, pp D1-D15, 1968. 15 p, 5 fig, 8 ref.

Descriptors: *Water management (Applied), *Artificial recharge, Overdraft, Pollution abatement.

Identifiers: *Great Miami River Valley, *Groundwater resources development, Water recycling, Declining groundwater levels.

A theoretical discussion on developing groundwater resources to meet future needs is presented. Provided that future developments are located at a sufficient distance from present pumping centers, the valley-train and gravel aquifers of the Great Miami River valley can possibly yield 300 mil gpd in the future. Used groundwater could be recycled as induced recharge to the aquifers; such recycling would increase the total potential aquifer yield to much more than the initial withdrawal yield. Deterioration in the water quality of used groundwater returned as river sewage would necessarily involve treatment costs. Overdraft, another future problem requiring solution, can be avoided by judicious location of future facilities in favorable hydrogeologic environments. Industrial reuse of water would reduce water consumption. Groundwater contamination, mostly derived from water induced from streams by pumping, can best be controlled by maintaining water of good quality in the streams. Artificial recharge of the aquifers and augmentation of low flow in the river can enhance both the efficient development of the groundwater resource and the maintenance of adequate quality of the river water. (Llaverias-USGS) W68-00961

GEOHYDROLOGICAL RECONNAISSANCE IN UPPER VOLTA,

Louis Berger, Inc, East Orange, N J. For primary bibliographic entry see Field 02F. For abstract, see W68-00964

WATER RESOURCES OF ORANGE COUNTY, FLORIDA,

U. S. Geological Survey W. F. Lichtler, Warren Anderson, and B. F. Joyner. Florida Div. of Geol. Rep. of Invest. No. 50, 150 p, 1968. 62 fig, 14 tab, 45 ref.

Descriptors: *Water resources, Florida, *Groundwater, *Surface waters, Hydrologic data, *Artesian wells, *Chemical analysis, Water level, Fluctuations, Water sources, Water yield, Streamflow, Duration curves, Hydrographs, Floods, Discharge measurement, Water pollution, Recharge wells. Identifiers: Orange County, Florida, Floridan

A study was undertaken to supply information for the development and management of water resources of the Orlando area, Orange County, Florida. Surface runoff is the principal drainage of the areas below 35 ft msl, and underground drainage prevails in areas above 105 ft. Lakes are the best source of surface water because most of the streams and swamps are dry during droughts. Flow-duration and flood records are tabulated. The surface water is soft, low in mineral content and high in color, and of fairly constant quality. Groundwater sources are an unconfined clastic aquifer of late Miocene to Recent age, several middle Miocene shallow discontinuous artesian aquifers, and the Eocene Floridan aquifer. The surficial aquifer yields small quantities of sometimes highly colored soft water. Upper artesian zones yield moderate quantities of hard water. The Floridan aquifer, which is the main water source of Orange County, is over 1,300 ft of porous limestone and dolomite and yields over 4,000 gpm in large-diameter wells. Water levels in the Floridan aquifer range from 15 ft above to more than 60 ft below msl. The water is moderately hard in the west and saline in the east part of the county. Groundwater use averages about 60 mgd, and 5.5 mgd of surface water is used for irrigation. (Knapp-USGS) W68-00976

GROUND WATER RESOURCES OF THE NORTHERN POWDER RIVER SOUTHEASTERN MONTANA, VALLEY,

U. S. Geological Survey. James O. Taylor.

Mont. Bur. of Mines and Geol. Bull. 66, 34 p, May 1968, 17 fig, 1 plate, 9 tab, 32 ref, 1 append.

Descriptors: *Groundwater, *Artesian wells, *Hydrologic data, *Water quality, Aquifers, Logging (Recording), Chemical analysis, Water levels, Hydrogeology, Data collections, Springs. Water sources, Observation wells, Water yield, Specific capacity, Transmissivity, Storage coefficient. Montana.

Identifiers: *Powder River Valley, Montana, Well data, Water-level measurements.

The domestic, stock, industrial, and municipal water supplies of the Northern Powder River valley depend on groundwater from the aquifers in the Late Cretaceous Fox Hills Sandstone and Hell Creek Formation, the Paleocene Fort Union Formation, and Pleistocene to Recent Terrace deposits. The most continuous and dependable aquifer is the Fix Hillsbasal Hell Creek artesian aquifer which averages 250 ft in thickness, has a mean transmissibility of about 820 gpd per ft, and a storage coefficient of about .00026. The recharge area is in the southeastern Montana, and water moves northwest to discharge into the Yellowstone River valley by leakage through overlying confining beds. The artesian aguifers in the Fort Union Formation are discontinuous and are recharged at various places, but the direction of movement is also northward to discharge through springs. Dissolvedsolids content in the groundwater is less than 1,000 ppm. Water in the Fox Hills and Hell Creek formation is soft; water from the higher formations is hard. Dissolved gas, mostly nitrogen, is found in the Fox Hills-basal Hell Creek aquifer. In general the water is satisfactory for domestic and stock use but unsatisfactory for irrigation. Supplies are adequate for present and projected future use. (Knapp-USGS) W68-00977

HYDROLOGY OF THE METAMORPHIC AND IGNEOUS ROCKS OF CENTRAL CHESTER COUNTY, PENNSYLVANIA,

U. S. Geological Survey. Charles W. Poth. Penn. Geol. Surv. Ground Water Rep. 4th Ser. Bull. W25, 84 p, 1968. 29 fig, 3 plate, 6 tab, 11 ref.

Descriptors: *Groundwater, *Metamorphic rocks, Cracks, Hydrologic data, Aquifers, * Water quality, *Chemical analysis, Water levels, Hydrogeology, Water table, Data collections, Water level fluctuations, Water sources, Water yield, Specific capacity, Pennsylvania.

Identifiers: Metamorphic rock hydrology, Pumping-test data.

An investigation of the hydrology of the rapidly growing suburban Chester area in southeastern Pennsylvania showed that the groundwater occurs in and moves through fractures in Precambrian and Paleozoic metamorphic and Triassic intrusive rocks. Water is available in several zones generally less than 200-ft deep but at depths greater than 300 ft in the Baltimore Gneiss. About 10% of the wells yielded over 50 gpm and 5% yielded over 330 gpm. Depth of weathering does not affect yield, but the weathered zone is an important storage reservoir. Wells in valleys yield more water and are shallower than wells on uplands or slopes. Yield decreases with increasing metamorphic rank. Most of the water was of the Ca-Mg bicarbonate type of low total dissolved solids content with a median of 146 ppm, a hardness of 3 grains per gal, and a pH of 6.6.
A large number of wells appear to be contaminated from local sources. Maximum yields range from 80 gpm in serpentine to 665 gpm in dolomite. Well locations are plotted on four 7.5-minute geological maps made in 1932. (Knapp-USGS) W68-00978

Field 04-WATER QUANTITY MANAGEMENT AND CONTROL

Group 4B—Groundwater Management

GROUND-WATER RESOURCES OF THE EAST-ERN SHORE OF VIRGINIA AND THE JAMES, YORK, AND RAPPAHANNOCK RIVER BASINS OF VIRGINIA, EAST OF THE FALL LINE, U. S. Geological Survey, George D. DeBuchananne.

U. S. Geol. Surv. Hydrol. Invest. Atlas HA-284, 2 sheets, 1968. text, 3 map, 2 tab, 18 ref.

Descriptors: *Groundwater, *Water wells, *Hydrologic data, Aquifers, *Water quality, Chemical analysis, Water levels, Hydrogeology, Water table, Water sources, Recharge, Subsurface waters, Hydrologic properties, Water yield, Specific capacity, Virginia, Safe yield, Runoff. Identifiers: Chemical analysis (Water), *Virginia coastal plain, *Groundwater information compilation.

Information from a variety of published and unpublished sources is compiled, and broad interpretations of existing information are made. The coastal plain is underlain by unconsolidated Cretaceous and younger sediments which dip southeast 20 to 80 ft per mile in a gradually thickening wedge. Yields of wells range from a few gpm to several hundred gpm. Most of the developed groundwater is from artesian aquifers. Recharge is estimated to be 1 mgd per square mile. Storage capacity ranges from 10 to 30% of aquifer vol. Estimated safe yield of the coastal plain aquifers is 4,000 mgd. Waters from the Eocene and aquiters is 4,000 mgd. Waters from the Eocene and Cretaceous aquifers are generally of good chemical quality for municipal and industrial uses. They are basically sodium bicarbonate waters with some local high fluoride concentrations. Water from Miocene and Quaternary aquifers generally has more iron than the waters of the older formations. The Atlas consists of 2 sheets with 3 maps and 1 cross section scaled 1:500,000 showing geology, groundwater availability groundwater uses and groundwater availability, groundwater use, and groundwater quality. Chemical analysis data are compiled in a table. A stratigraphic chart is in-cluded. (Knapp-USGS) W68-00979

WATER-PHYSICAL PROPERTIES OF THE EUPHRATES VALLEY SOILS, Giprovodkhoz Minmeliovodkhoza SSSR.

For primary bibliographic entry see Field 02G. For abstract, see.

4C. Effects on Water OF Man6s Non-Water **Activities**

BOWLING V CITY OF OXFORD (DAMAGES FROM-DAM COLLAPSE).

267 N C 552; 148 S E 2d 624-630 (1966).

Descriptors: *North Carolina, *Dam failure, *Impounded waters, *Earth dams, Dams, Reservoirs, Judicial decisions, Reservoir leakage, Seepage, Water works, Reservoir operation, Dam construc-

tion, Drainage. Identifiers: *Remedies (Legal aspects), *Damage (Legal aspects).

This was an action for damages by downstream owners for injury sustained when defendant's dam collapsed, flooding and deposition debris on plaintiff's property. Plaintiffs undertook to state two causes of action-negligence and trespass. The trial court entered a judgment of nonsuit against plainreservoir impounded by an earthen dam. For a long period of time prior to the collapse, there had been a leak in the dam, and for several hours before the collapse. This leak had grown larger. There was also a seepage around a drain pipe running through the dam. For two days before the collapse the volume of water flowing from the bottom of the dam had been increasing, and was of a muddy color. This court held that plaintiff had made out a prima facie case. The operation of a waterworks

system is a proprietary rather than a governmental function, therefore city is liable for negligent operation. One who maintains a dam to impound waters into a reservoir is not an insurer against damage caused by breaking of the dam, but is liable if negligence in construction or maintainence is shown. (Kirkconnell-Fla) W68-00781

HALLTOWN PAPERBOARD CO V C L ROBIN-SON CORP (RIPARIAN RIGHT TO NATURAL FLOW).

148 S E 2d 271-275 (W Va 1966).

Descriptors: *West Virginia, *Riparian rights, *Natural flow, Competing uses, *Pumping, Judicial decisions, Riparian owners, Natural flow, Doctrine, Relative rights, Stream flow, Water law, Jurisdiction, Consumptive use, Irrigation water, Industrial use, Reasonable use, Withdrawal.

Identifiers: Upper owner, Lower owner, Water Resources Board (W Va), *Injunction.

This was an action to enjoin an upper riparian owner from pumping out large quantities of stream water on the ground that it left the plaintiff lower riparian owner with insufficient water to operate its riparian owner with insufficient water to operate its paperboard plant. Plaintiff owns and operates a paperboard plant which uses water from Flowing Stream Run. Defendant owns and operates an orchard approximately one mile upstream from plaintiff's plant. Defendant installed a pumping station and pumped large quantities of water from the stream to irrigate his fruit trees. The decrease in flow caused by defendant's pumping on three occasions caused plaintiff to have to completely shut down his manufacturing plant due to lack of water down his manufacturing plant due to lack of water. The courts of West Virginia have long recognized a property right in a riparian owner to the flow of waters through or adjacent to his land. Since this controversy deals with property rights, the Water Resources Board has no jurisdiction over it, and plaintiff need not seek relief from the Board before coming into court. The injunction was granted. Kirkconnell-Fla) W68-00785

STEPHENS V KENTUCKY (DAMAGE TO LAKE FROM HIGHWAY CONSTRUCTION).

397 S W 2d 157-159 (Ct App Ky 1965)

Descriptors: *Kentucky, *Sitting, *Road construc-tion, Judicial decisions, Silt, Mud, Highways, Lakes, Desilting, Surface water, Erosion, Reasonable use, Damage. Identifiers: *Just compensation, Damages (Legal

aspects), Upper owner, Lower owner.

This was an action against the commonwealth of Ihis was an action against the commonwealth of Kentucky for damages arising out of alleged injury from highway construction. The commonwealth constructed a highway some 1000 feet up the watershed line from a small lake on plaintiff's property. The excavation and fill work left an unseeded and unsodded area exposed to the weather for about a year. Mud and silt from this area flowed into and damaged plaintiff's lake. The court held that the damage to plaintiff's lake constituted a taking for which just compensation must be paid. The ing for which just compensation must be paid. The court analogized the situation to the rule that a riparian owner may not use his land in such a way as to injure a lower owner. Judgment was for plaintiff. (Kirkconnell-Fla) W68-00792

4D. Watershed Protection

RAINFALL EFFECTS ON SOIL SURFACE CHARACTERISTICS FOLLOWING RANGE IMPROVEMENT TREATMENTS,
U. S. Department of Agriculture, Agricultural Research Service, Southwest Watershed Research Center, Tucson, Arizona.
For primary bibliographic entry see Field 02A.

For abstract, see

W68-00739

DIEFENBAKER LAKE EFFECTS OF BANK EROSION ON STORAGE CAPACITY,

Canadian Dep of Energy, Mines and Resources. R. O. Van Everdingen.

Inland Waters Branch, Dep of Energy, Mines and Resources, Tech Bull No 10, 1968. 21 p, 17 fig,

Descriptors: *Bank erosion, *Storage capacity, Sediment load, Usable storage. Identifiers: *Lake Diefenbaker, Accretion profiles, Erosion resistive forces, Canada

Each of the erosive and resistive forces that plays a role in bank erosion of Lake Diefenbaker, Saskatchewan, Canada, is discussed. Examples of bank erosion phenomena observed in the area of the Riverhurst Ferry on Diefenbaker Lake are provided together with a comparison of the sediment load of the South Saskatchewan River at Lemsford, with accretion profiles near the Riverhurst Ferry. It is shown that accelerated bank erosion, mainly by wave action, accounts for most of the changes in the reservoir cross-section observed. An estimate is included of the eventual decrease in storage capacity of the Lake, which is expected to result from bank erosion processes. Decrease in total storage capacity, available at F.S.L., is estimated to be 21,600 ac-ft, while decrease available at low level would be 225,000 ac-ft. Bank erosion effects will also account for an increase in usable storage of 204,000 ac-ft (7.4%). (Llaverias-USGS) W68-00804

05. WATER QUALITY MANAGEMENT AND PROTECTION

5A. Identification **OF** Pollutants

AN EVALUATION OF THE USE OF ESCHERICHIA COLI SEROGROUPS AS A MEANS OF TRACING MICROBIAL POLLUTION IN WATER, Pennsylvania State Univ, University Park.

Paul J. Glantz and Thomas M. Jacks. Water Resources Res, Vol 4, No 3, pp 625-638, June 1968. 14 p, 7 fig, 6 tab, 9 ref.

Descriptors: *Water pollution, *Water pollution sources, Water quality, Water supply, Bacteria, E. coli, Coliforms, Enteric bacteria, Sewage bacteria, Bioindicators, Microbiology. Identifiers: *Bacteria strain identification, Serolog-

ical identification, Serogroups.

Escherichia coli serogroups were used as a means of tracing pollution, and total and fecal coliform counts were utilized to determine the degree, location, and variations of microbial pollution of water. In one area a lake served as a reservoir for the constant influx of coliform bacteria from two streams. Total and fecal coliforms increased from May through July, declined in Aug and Sept, and appeared subject to human and animal activity and weather. E. coli serogroups were traced upstream from the lake either via Paradise Creek or the Fish Hatchery, and through the Hatchery holding ponds to their spring water source. In the second study treated sewage effluent entering one of two branches of Spring Creek did not appear to furnish most of the total and fecal coliform bacteria as microbial pollution from other sources occurred. The E. coli serogroups isolated at the different points were traced to their probable upstream source. The results of this study indicate that tracing microbial pollution by serologically identifying the E. coli strains is feasible. (Knapp-USGS) W68-00972

5B. Sources of Pollution

REDDICK V PIPPIN (STREAM POLLUTION).

421 S W 2d 225-229 (Mo 1967).

Descriptors: *Water pollution, *Sewage lagoons, Sewage disposal, Sewage bacteria, Sewage treatment, Riparian rights, Septic tanks. Identifiers: Evidence.

The plaintiff brought an action for actual and punitive damages for alleged continuous discharge of a large quantity of raw sewerage containing detergents and other deleterious and noxious substances from defendants' land on to the adjacent land of plaintiffs, polluting a brook and a residential well. In a trial without a jury the trial court granted judgment for the defendant. The source of the trouble was a lagoon built on the defendants property to treat sewerage. The lagoon had a discharge pipe at the top to allow the treated water to seep off. The seepage entered a drainage ditch that crossed the plaintiffs land. The court affirmed the judgment for the defendant and held that the evidence did not show that the lagoon was inadequate for sewerage dumped into it. The defendants' evidence showed that the lagoon was adequate and that 95 to 98% of the harmful bacteria was removed before the water was discharged. Further, the plaintiffs' evidence did not show whether his well was polluted by the lagoon or his uphill neighbors' septic tanks. (Horner-Fla) W68-00756

BELL INDUS, INC V JONES (LICENSE TO DISCHARGE WASTEWATER ON ANOTHER'S LAND).

220 Ga 68: 141 S E 2d 533-576 (1965).

Descriptors: *Georgia, *Easements, *Industrial wastes, *Waste water disposal, Judicial decisions, Waste water, Remedies, Water law, Legal aspects, Legislation, Wastes, Waste disposal, Waste dumps, Waste water (Pollution), Southeast U S, Industries. Identifiers: *Remedies (Legal aspects), Georgia Water Quality Control Act.

This was an action to enjoin the discharge of industrial wastes onto plaintiff's property by defendant, which claimed rights by easement granted by plaintiff to defendant's predecessor. Plaintiff had been past-president of a company which occupied the plant now occupied by defendant. While president, plaintiff granted a parol license to the company to discharge laundry waste water through a pipe onto plaintiff's land. Plaintiff later executed an easement to the company with the formality of a deed, permitting the company to discharge the waste water on his land. The court found that defendant held an easement which permitted it to discharge waste water on plaintiff's property, and denied the injunction. A parol license is not revocable where the licensee has incurred expense in reliance thereon. The easement was obtained for a valuable consideration. The term laundry waste water was broad enough to include increased concentrations of waste from defendant. The Georgia Water Quality Control Act of 1964 does not undertake to alter the general rules of law in regard to private nuisance. (Kirkconnell-Fla) W68-00796

EFFECT OF CHEMICAL STRUCTURE ON THE BIODEGRADABILITY OF **ORGANIC** MOLECULES, Cornell Univ., Ithaca, N. Y.

Martin Alexander.

Cornell University Water Resources and Marine Sciences Center, Technical Report No 11, Aug

Bacteria, *Biodegradation, Halogenated acids microorganisms, Microbial degradation, Sewage microorganisms, Tertiary alcohols, Quarternary carbon compounds

Identifiers: Arthrobacter bacteria, *Dehalogenation. Molecular recalcitrance.

The biodegradability of substituted aliphatic acids and alcohols by microorganisms in sewage was studied using the BOD technique. With the exception of the mono-methyl-substituted acids, the alphasubstituted acids were more refractory to microbial attack than the omega-substituted acids. The mono-methyl-substituted acids were readily degraded. Multiple substitution caused a compound to be more resistant to attack than compounds with a single substituent. Acids and alcohols with a tertiary or quarternary carbon were generally resistant to microbial degradation. Bacteria, tentatively identified as Arthrobacter species, which are able to debrominate omega-bromo-hexanoic and -heptanoic acids but which do not utilize them for growth occur in large numbers in sewage. The alpha-substituted acids or the omega-substituted acids having less than six carbons were not dehalogenated. (Author) W68-00898

BIOLOGICAL, CHEMICAL AND PHYSICAL FACTORS CONTROLLING THE CONCENTRATION OF MANGANESE IN THE HYPOLIMION OF IMPOUNDMENTS,

Georgia Institute of Technology, Atlanta.

Robert S. Ingols. Completion Report for Office of Water Resources Research Project A-005-GA, June 1968

*Manganese, *Hypolimnion, *Impoundment limnology, Microbiological metabolism, Anaerobic conditions, Biological reduction, Bacterial activity, *Soluble iron compounds, Iron

Piedmont Plateau, Formaldoxine Identifiers: procedure, Phenanthroline procedure.

Biological activity is known to be needed to remove the dissolved oxygen from the hypolimnion, but literature continues to have claims for the direct intervention of bacteria in lowering the valence of and dissolving manganese. If the higher valence state of manganese and bacteria are in direct contact then the more active the bacteria or the more favorable the conditions for their growth, the more manganese should be dissolved. An inoculated culture medium should dissolve more manganese than a sterile medium. Results were obtained that lent support to the active participation of bacteria, but refined procedures gave completely negative results. The sterile medium dissolved more manganese. The more favorable the medium for bacterial activity, the less manganese was dissolved Because iron is frequently found in lake and well waters with manganese, the effect of iron in the medium on the solution of manganese was studied No aid was found from iron in increasing the amount of manganese in solution. Experimental data support the conclusion that after bacteria remove the dissolved oxygen, the manganese is dis-solved according to purely chemical factors in the environment of the manganese dioxide. (WRC-Ga) W68-00902

RELEASE OF HERBICIDES FROM CLAY MINERALS AS A FUNCTION OF SOIL MOISTURE,

North Carolina State Univ., Raleigh. Hubert Donovan Scott. M.S. Thesis, Dept Soil Science, N. C. State Univer-

Descriptors: *Herbicides, *Pesticide residues, *Agricultural wastes, Persistence, Soil treatment, Water pollution sources, Soil moisture.

The influence of soil moisture content on the release of six C super 14-labeled herbicides applied at two normally-used field rates to two clay

minerals was studied. Clay-herbicide suspensions were prepared and subjected to various pressure increments in the pressure membrane extractor, and the following determined: I Volume of extract at each pressure increment; II pH of the extract; III Concentration of herbicide in the extract, as measured by the liquid scintillator; and IV Amount of herbicide remaining as calculated by difference. Soil moisture content had a pronounced effect on the concentration of herbicides in the soil solution. On kaolinite, the highest total herbicide concentration occurred in the bulk solution away from the particle. On montmorillonite, the highest total herbicide concentration occurred in the extracts expressed at the lower pressures, and as the moisture content decreased, there was a corresponding decrease in herbicide concentration. The pH of the soil solution was thought to determine the degree of adsorption to a much greater extent than the cation exchange capacity and surface area, at least at normally-used field rates, because the percentage of adsorption sites occupied would be low. (Author) W68-00906

LIGNIN XIV. GEL CHROMATOGRAPHY AND THE DISTRIBUTION IN MOLECULAR SIZE OF LIGNIN SULFONATES AT SEVERAL ELECTROLYTE CONCENTRATIONS,

Washington Univ., Seattle, Department of Chemical Engineering. For primary bibliographic entry see Field 02K.

For abstract, see W68-00910

THE DISTRIBUTION OF DISSOLVED OXYGEN STREAM WITH TIME VARYING IN A STI

Manhattan College, NY Dominic M. Di Toro, and Donald J. O'Connor. Water Resources Res, Vol 4, No 3, pp 639-646, June 1968. 8 p. 4 fig. 5 ref.

Descriptors: *Water pollution, *Biochemical oxygen demand, Chemical oxygen demand, Stream-flow, Path of pollutants, Pollutants, Water pollu-tion effects, Water quality, Oxygen sag, Mathematical studies.
Identifiers: *Dissolved oxygen deficit.

The solutions of the equation that describe the distribution of biochemical oxygen demand (BOD) and dissolved oxygen deficit (DOD) in an idealized natural stream with a time varying velocity can be obtained intuitively from an extension of the well known solutions which apply for a constant stream velocity. By introducing the concept of the release time, that is, the time at which the particle of water being observed at point x at time t was released at point x=0, the solution for the time varying flow and velocity follows. The formal solution can also be obtained by using the LaPlace transform with respect to the space variable x. An application of this analysis to the effect of random component of velocity on the BOD and DOD distributions are approximately equal to the coefficient of variation of the velocity times the BOD and DOD distributions calculated using the mean velocity. (Knapp-USGS)

GROUND-WATER QUALITY STUDY OF SEVERANCE BASIN, WELD COUNTY, COUNTY. COLORADO.

Colorado State Univ, Fort Collins. Nikolas F. White, and D. K. Sunada Water Resour Res Rep, Colorado State Univ, Apr 1966. 29 p, 6 fig, 4 tab, 8 ref.

Descriptors: *Ground water, *Water quality, *Water pollution, Water balance, Evapotranspiration, Aquifers, Groundwater flow, Geology, Waste water, Drainage effects, Pollutants, Surface ground-water relationship.

Pollution of ground-water aquifers in the United States is becoming a problem of increasing im-

Field 05-WATER QUALITY MANAGEMENT AND PROTECTION

Group 5B-Sources of Pollution

portance. To study this problem, a small aquifer was selected near Windsor, Colorado. This aquifer was selected near windsor, Colorado. This adulted had as pollution sources: cattle feedlots, fertilizers, oil field brine pits, geologic strata, and irrigation water. The analysis of the problem consisted of a study of the individual pollution sources in the basin and an overall study of the basin using a mass balance technique. It was found that each of the above sources at a single entity contributed very little to the contamination of the aquifer. The primary cause of pollution was the high evapotranspira-tion rate as opposed to the low ground-water and surface water discharge from the area. This ration of evapotranspiration to ground-water and surface water outflow produced an increase in the total dis-solved solids of 173 ppm/yr. W68-01015

5C. Effects of Pollution

THE POST-GLACIAL DEVELOPMENT OF GRANE LANGSO,

For primary bibliographic entry see Field 02H. For abstract, see.

THE RELATION BETWEEN SULFUR AND CARBON IN SEDIMENTS FROM THE ENGLISH LAKES,

Toronto U., Canada. For primary bibliographic entry see Field 02H. For abstract, see W68-00679

EUTROPHICATION OF LAKES BY DOMESTIC DRAINAGE.

A. D. Hasler.

Ecol, Vol 28, pp 383-395, 1947. 13 p, 1 tab, 2 fig.

Descriptors: *Eutrophication, Algae, plants, Bibliographies, Cyanophyta, Fresh water fish, Lakes, *Lake Zurich, *Municipal wastes, Nutrients, Nuisance algae, Oligotrophy, Phytoplankton, *Reviews, *Water pollution effective the property of the

The reports of purposeful fertilization of lakes are very meager, but inadvertent eutrophication has been recorded for many lakes, principally those in Europe. A classic example is Lake Zurich in which 2 basins are separated by a narrow passage. The larger Untersee (141 m deep) was once decidedly ologotrophic but now trends strongly toward eutrophy. The shallower Obersee (50 m deep) eutrophy. The shallower Obersee (50 m deep) shows virtually no effects of eutrophy. The Untersnows virtually no effects of eutrophy. The other-see is rimmed by numerous communities (com-bined population of 110,000) (Zurich contributes no sewage) but the Obersee lacks such communi-ties. Evidences of eutrophication of the Untersee date back to last century and are the increase of nuisance algae; the disappearance of desirable fish and replacement by coarse fish; and increases in the chloride ion. The author reviews the fertilization process in numerous lakes in Europe and the United States. He concludes that fertilization almost certainly hastens the extinction of a lake and thus limits its benefits to man to a relatively short period. (Byrne-Wisc) W68-00680

PALEOLIMNOLOGICAL STUDY ON ANCIENT LAKE SEDIMENTS IN JAPAN, Otsu Hydrobiological Station, Otsu, Japan

For primary bibliographic entry see Field 02H. For abstract, see . W68-00681

AN EXPERIMENT IN THE ARTIFICIAL CIR-CULATION OF A SMALL MICHIGAN LAKE, Michigan Dept Cons; Div Cons, Michigan State College; Colorado Coop Fish Res Unit, Colorado A and M College. For primary bibliographic entry see Field 02H. For abstract, see W68-00682

GREAT LAKES LIMNOLOGICAL INVESTIGA-TIONS.

A. M. Beeton. Univ of Mich, Great Lakes Res Div Pub, Vol 4, pp 123-128, 1960, 6 p.

Descriptors: *Eutrophication, Great Lakes, *Lake Descriptors: *Eutrophication, Great Lakes, *Lake Erie, Lake Huron, Lake Michigan, Lake Superior, *Fish populations, Lakes, Dissolved oxygen, Water temperature, Benthic fauna, Mayflies, *Oxygen sag, Thermal stratification, Tubificids, Midges, Caddisflies, Lake trout, Lampreys, Chemical analysis, Dissolved solids, Seasonal, Bays, Reviews. Identifiers: United States Bureau of Commercial

Studies of Lake Erie for the past 30 yr indicate that eutrophication is accelerating. The lake has changed from one that supported a large cold water fish population, demanding a high oxygen content, into one dominated by warm water species adapted to higher temperatures and lower oxygen concentrations. Major changes have also taken place in its bottom fauna. Prior to summer 1953, the mayfly larvae averaged about 400/sq m of lake bottom; a larvae averaged about 400/sq m of lake bottom; a long calm in summer 1953 produced a thermal stratification that severely depleted oxygen in the bottom waters, following which there were only 44 live mayfly larvae/sq m. Caddisfly larvae, once abundant, averaged less than 1/sq m in 1957. Tubificids increased from 12/sq m in 1929 to 551/sq m in 1957, and midge larvae from 56/sq m in 1929 to 299/sq m. Lake Erie is the most changed of the Great Lakes. The trout population of Lake Michigan was rapidly depleted recently, but the loss largely resulted from lamprey predation. Lake Superior shows surprising uniformity of chemical conditions both areally and bathymetrically. Oxygen saturation occurs even in the deepest waters of Lakes Huron, Michigan, and Superior, although concentrations are reduced in Green Bay and Saginaw Bay; certain areas of Lake Erie are characterized by low concentrations. (Byrne-Wisc) W68-00683

RECENT CHANGES IN THE TROPHIC NATURE OF LAKE WASHINGTON--A REVIEW.

G. C. Anderson. Trans 1960 Seminar On Algae and Metropolitan Wastes, Robt A Taft San Eng Center Tech Rept, W61-3, pp 27-33, 1961. 7 p.

Descriptors: *Eutrophication, *Lakes, Oligotrophy, *Water pollution sources, *Water pollution effects, Washington, Bioindicators, Hypolimnion, Turbidity, Human population, Biological communities, Phytoplankton, Biological communities, Phytoplankton, Cyanophyta, Oxygen demand, Oxygen sag, Anaerobic conditions, *Water pollution control, Sewage districts, Municipal wastes, Growth rates. Identifiers: Lake Washington, Puget Sound.

Lake Washington has changed recently from a relatively clear, oligotrophic lake to one that is now eutrophic. This is in response to the increasing discharge of sewage into the lake from Seattle and other communities bordering the lake, as well as drainage from septic tanks. The response to indrainage from septic tanks. The response to increasing pollution is shown by limnological studies made in 1933, 1950, and 1955-58. An increased growth of phytoplankton largely cyanophyta, notorious indicators of pollution, appeared for the first time in 1955. The increase in the algal crop has been a regular one each year since 1950. Changes resulting from the recent increase in productivity are: decreased water transparency; oxygen con-sumption and nutrient release in the hypolimnion have progressively increased during summer stratification; the hypolimnetic oxygen deficit has increased three times since 1933; and in 1957 for the first time, the deepest waters became anaerobic for a short time. If the fertilization of the lake continues, blooms of nuisance algae will be produced in a very few years. The Municipality of Metropolitan Seattle was formed in 1958 to unify sewerage services for the total community. Plans call for the ultimate diversion of all sewage to Puget Sound. (Byrne-Wisc) W68-00684

RESPONSES OF A MARL LAKE TO FER-

Inst Fish Res, Michigan Dept Cons, and Dept Fish and Wildlife, Michigan State University.
F. F. Hooper and R. C. Ball.

Trans Amer Fish Soc, Vol 93, pp 164-173, 1964. 10 p, 4 fig, 3 tab, 19 ref.

Descriptors: *Eutrophication, Michigan, *Marl, *Lakes, *Fertilization, Nitrogen, Phosphorus, Potash, Turbidity, Coagulation, Phytoplankton, Nannoplankton, On-site date collections, Periphyton, Bibliographies, Nutrients, Dissolved

The authors believe that benthic algae are more effective than are planktonic algae in utilizing the nutrient additives to marl lakes. Inorganic fertilizer was applied in mid-summer for three consecutive years to a shallow marl lake in Michigan in an effort to find means for improving fishing in an unproductive lake. The fertilizer applied in 1954 and 1956 contained 10% phosphorus, 10% nitrogen, and 10% potash. The rate was doubled in 1955 because the 1954 application (50 lb/ac) resulted in little response by the phytoplankton. Fertilization caused the coalescence of suspended marl, rather than chemical precipitation or an increase in phytoplankton. There was no apparent increase in the organic fraction following 1954-1955 fertilization; however, during the 1956 study the use of a Millipore filter did reveal a small increase. Inorganic nitrogen and phosphorus remained in the water for a very short period only, but organic phosphorus persisted 25 days or more. No living phytoplankton cells were detected either before or phytoplankton cells were detected einer before of after fertilization until the Millipore filter was used when the presence on nannoplankton was found following fertilization. The increase in periphyton algae was well marked in all three years following fertilization. (Byrne-Wisc) W68-00685

PRIMARY PRODUCTIVITY AND LIMITING FACTORS IN THREE LAKES OF THE ALASKA PENINSULA, Dept. of Fish, University of Michigan.

For primary bibliographic entry see Field 02H. For abstract, see. W68-00686

ENVIRONMENTAL CHANGES IN LAKE ERIE, A. M. Beeton.

Trans Amer Fish Soc, Vol 90, pp 153-159, 1961. 7

Descriptors: *Eutrophication, History, Benthic fau-Descriptors: "Eutropnication, History, Benthic faunas, "Biological communities, Phosphorus, Fish populations, *Lake Erie, Great Lakes, Bioindicators, Pikes, Cisco, Commercial fish, Water temperature, Dissolved oxygen, Profundal zone, Coliforms, Plankton, Nitrogen, Chemical properties, *Environmental effects, *Influent streams, Flow rates.

Data compiled during the past sixty years indicate that major changes have occurred in the bottom and fish faunas of Lake Erie. The bottom fauna was early dominated by Hexagenia nymphs, but midge larvae and oligochaetes are now the most abundant forms; these changes seem to be confined to the western and central basins of the lake. Blue pike and cisco once dominated the commercial catch but are now scarce and have been replaced by other species. The major ions have increased as much ad 10 mg/1, but increases in the concentrations of nitrogen and phosphorus compounds could have the most important biological effects. Mean have the most important biological effects. Mean annual water temperatures are about 2 deg F warmer now than in the 1918-28 period. The number of coliforms was increased. Low dissolved oxygen levels have been recorded several times since 1930, and very low concentrations have recently been found in bottom waters covering many sq mi of the central basin. Any great changes in the chemistry or in the plankton of the lake must originate in changes in the characteristics of the waters flowing into the lake especially in the waters flowing into the lake, especially in the

western basin where the Detroit River inflow results in a flushing rate of about two mo. More data are needed on the past and present chemical characteristics of this and other influent streams. (Byrne-Wisc) W68-00687

URIE V FRANCONIA PAPER CORP.

State of New Hampshire aremedies for stream pollution₀.

107 N H 131, 218 A 2d 360-363 (1966).

Descriptors: *New Hampshire, Water law, *Pollution abatement, Judicial decisions, Industrial wastes, Legislation, *Remedies, *Water pollution. Identifiers: Constitutional law.

The case involved an action by plaintiff Urie and others, some being riparian owners on the Pemigewasset River, to enjoin the defendant paper and pulp manufacturer from further polluting its waters. It was alleged that odors from the polluted waters were caused by hydrogen sulfide gas, highly offensive in smell and harmful to lead-based paint. The main defense of the manufacturer was that the river was classified by the legislature as 'Class D' water. Polluters causing water to fall below the D classification were allowed ten years to abate the pollution which lowered the water below this minimum standard. However, the court pointed out that while this provision would bar suits for public muisance for the ten year period, the legislature was probably without the constitutional power to likewise bar suits for private nuisance, since this would constitute a taking of private property for a non-public purpose. Since there is nothing in the statute to indicate any legislative intent to take away any private rights, it was held that plaintiffs' petition stated a cause of action for equitable relief. (Patterson-Fla) W68-00743

CITY OF SPRINGDALE V WEATHERS (POL-LUTION).

410 S W 2d 754-760 (Ark 1967).

Descriptors: *Water pollution, Flow, Municipal wastes, Cities, Eminent domain, Riparian rights, Riparian land, Property values, Sewage, Water law, Legal aspects.

The litigation concerned damages to a dairy farm caused by the discharge of sewage from a disposal plant. The main question involved the time that the permanent damage occurred to the property because a three year statute of limitations was applicable. The jury found that the farm had been permanently damaged and that it became obvious to the plaintiff in 1963. The defendants contention was that the injury dated from the construction of the plant in 1937. The court held that in an action for damages for permanent injury to real estate caused by pollution the limitation begins to run at the time when it became obvious that a permanent injury has been suffered. The majority of the court agreed with the action of trial judge in sending the question to the jury to decide. The three dissenting justices felt that there was no substantial evidence to support the finding that the permanent damage occurred in 1963. (Horner-Fla)

HODGES V BUCKEYE CELLULOSE CORP (CONSTITUTION ALITY OF STATUTE AL-LOWING INDUSTRIAL POLLUTION). 174 So 2d 565-568 (1st D C A Fla 1965).

Descriptors: *Florida, Judicial decisions, *Legislation, *Remedies, Water law, Watercourses (Legal), *Water pollution, Industrial wastes. Identifiers: *Constitutional law.

The plaintiffs, landowners near the Fenholloway River, appeal from an order of the chancellor

granting a motion to strike part of their complaint against the defendant corporation. The defendant was discharging industrial pollutants into the river, a practice allowed by Fla. Stat. ch. 24952 (1963), thereby allegedly damaging the plaintiffs' property The plaintiffs claimed that since the state permitted the pollution damaging their property without requiring just compensation, chapter 24952 was unconstitutional and repugnant to the general laws of Florida. The court in the instant case affirmed the order granting the motion to strike. The court reasoned that in order to question the constitutionality of an act one must show that personal or property rights will be seriously affected by its operation. Since the statute in issue only removes restrictions otherwise imposed by the state upon Taylor County industries against discharging industrial waters into the Fenholloway River, and does not take away any private person's right to sue for any tort in connection with the operation of industries, the plaintiffs are not adversely affected by its operation and have no standing to challenge its constitutionality. (Patterson-Fla) W 68-00757

CAULEY V UNITED STATES (STREAM POL-LUTION DAMAGE).

242 F Supp 866-870 (D C E D N C 1965).

Descriptors: *Federal Government, *Fishkill, Ponds, *Water pollution effects, Judicial decisions, *North Carolina, Fish, Damage, Water law, Pollutants, Watercourses (Legal), Freshwater, Fresh water fish, Farm ponds. Identifiers: *Federal Tort Claims Act, Remedies (Legal aspects).

This action was brought under the Federal Tort Claims Act. Plaintiff was in control of a pond which was stocked with fish. Federal agents discovered and dynamited an illegal distillery some 3/4 of a mile upstream from plaintiff's pond. Water flowed from the distillery by means of a small ditch into a stream, then into a canal which supplied plaintiff's pond with water. Plaintiff claimed that fermeting mash negligently released into the ditch by federal agents in dynamiting the distillery had flowed into and killed fish in plaintiff's pond. The court found that plaintiff had failed to prove that fermeting mash released by the federal agents, rather than spend mash released by the operators of the distillery prior to the dynamiting, killed the fish. Judgment was for the defendant. (Kirkconnell-Fla) W68-00788

KENNEDY V MOOG, INC (POLLUTION OF DITCH AS TRESPASS).

48 Misc 2d 107, 264 N Y S 2d 606-616 (Sup Ct N Y 1965).

Descriptors: *New York, *Ditches, Water pollution, *Pollution abatement, Sewage, Judicial decisions, Damages, Remedies, Riparian rights, Riparian waters, *Watercourses (Legal). Identifiers: *Trespass.

The plaintiffs brought an action to enjoin the defendants from releasing treated sewage upon their farm land, claiming irreparable damage by flooding and demanding money damages. Defendant released about 10,000 gallons of effluent daily into a ditch running from defendant's upper land and terminating in plaintiffs' lower land, thereby flooding five acres of pasture. The court first noted the initial distinction between a natural water-course, to which riparian rights attach and the reasonable use rule applies, and no water-course, where landowners have no riparian rights. However, the court only stated that the ditch in question was not an intermittant stream, due to its bank and bed characteristics. After discussing pollution, riparian rights and rules for issuing injunctions, the court noted that this was a case of first instance. The court held for the plaintiff on the ground that the quantity of effluent damaging plaintiffs' land con-

stituted a direct, recurrent, and intentional trespass, stating that by its trespass the defendant flooded plaintiffs' land in order to keep its own from flooding, thereby appropriating the land pro tanto in the nature of quare clausum fregit. (Patterson-Fla) W68-00800

TEMPERATURE AND WATER-QUALITY CON-DITIONS OF THE PATUXENT RIVER ESTUA-RY, MARYLAND, JANUARY 1966 THROUGH DECEMBER 1967,

U S Geological Survey. Robert L. Cory, and Jon W. Nauman. U S Geol Surv open-file rep, 1968. 70 p, 11 fig, 5 tab. 9 ref.

Descriptors: *Thermal pollution, *Thermal powerplants, *Path of pollutants, *Temperature, *Water quality, Maryland, Electric powerplants, Dissolved oxygen, Turbidity, Salinity, Streamflow, Stagedischarge relations, Estuarine environment. Identifiers: Patuxent estuary, Climatic fluctuations.

The effects of a coal-fueled powerplant condenserwater discharge of 500,000 gpm on the temperature of water in the Patuxent River estuary from Jan 1966 to Dec 1967 were studied. Temperature of the surface water, surface salinity, dissolved oxygen, turbidity, tide-stage, and bottom temperature data are presented in graphs and tables. Surface temperatures 1,000 ft downstream from discharge averaged 4 deg C higher than normal and at times were 8 deg higher. Temperature rise was highest in winter. Infrared imagery showed elevated surface temperatures as far as 3 mi upstream at flood tide. Mean annual salinity varied from 12.3 ppt in 1966 to 9.9 ppt in 1967. Dissolved oxygen ranged from 3.2 to 15.6 mg/l, and oxygen saturation from 55% to 152%. Turbidity was inversely related to salinity. Extreme tide range was 6.7 ft and mean water levels were highest in summer and lowest in winter. Water stages are more affected by wind than by river flow. (Knapp-USGS)

LAKE-ORIENTED SUBDIVISIONS IN NORTH CAROLINA: DECISIONS FACTORS AND POLICY IMPLICATIONS FOR URBAN GROWTH PATTERNS, University of North Carolina at Chapel Hill and

University of North Carolina at Chapel Hill and North Carolina State University at Raleigh. For primary bibliographic entry see Field 06B. For abstract, see . W68-00849

THE PRODUCTION ASPECT OF WATER BODY TYPOLOGY,

S. Ehrlich. Hydrobiol, Vol 17, pp 326-332, 1061. 7 p, 1 fig, 26 ref.

Descriptors: *Eutrophication, Productivity, Proteins, Reviews, Carbohydrates, *Nutrients, Inorganic compounds, Systematics, *Lakes, *Systems analysis, Oligotrophic, Dystrophic, Sedimentation rates, Alkaline waters, Bibliographies.

It is the author's opinion that, from the biological and the fisherman's point of view, it is not glucose (or calories) but proteins that seem to determine the biological productivity of water. The accumulation of organic matter in acid water bodies that have a poor nutrient supply creates a low-production, dystrophic water body because of the better conservation of the organic matter which fills up the lake more rapidly than if the water were eutrophic. A simple scheme of classifying the productivity aspects of water bodies in relation to degree of composition is suggested. The author states that if the nutrient supply is a superabundance of minerals only, as it is in the excessively alkaline waters of arid regions, biological productivity remains low, the turnover is high, and the accumulation of large amounts of organic debris is prevented. Various schemes for classifying

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water bodies are reviewed and analyzed. (Byrne-W68c00854

THE INFLUENCE OF THE MINERAL COM-POSITION OF THE MEDIUM ON THE GROWTH OF PLANKTONIC ALGAE. PART I. METHODS AND CULTURE MEDIA,

London Univ., Queen Mary Coll., England.

J Ecol, Vol 30, No 2, pp 284-325, Aug 1942. 42 p, 8 fig, 22 tab, 43 ref.

*Eutrophication, Phytoplankton, Descriptors: Bibliographies, *Algae, *Chemical properties, Nutrients, Lakes, Tests, Nitrogen, Phosphorus, Calcium, Magnesium, Sodium, Silica, Diatoms, Resistance, *Plant growth regulators, Fresh water lakes, Laboratory tests.

The author reports that all of the algae used in a test series, with but one exception, grow equally well when the media were supplied with nitrogen sources from nitrate salts or amonium salts, so long as the nitrogen concentration was within the optimum range; in lower nitrogen concentrations, growth was generally better when the source was a nitrate salt. The experiment was one in which 14 planktonic algae were maintained in culture media simulating the chemical compositions of natural fresh waters. Algae were found to respond with considerable difference to concentrations of calcium, magnesium, potassium, sodium, and silica. The calcium requirement was often lower in media with higher magnesium concentrations, while excessive potassium increases tolerances for higher concentrations of calcium and magnesium. Appreciable quantities of silica were found to be necessary only for the growth of diatoms; some algae, in fact, were inhibited by the presence of dissolved silica. There was a wider range in phosphorus concentration when nitrogen was derived from a nitrate source rather than from an ammonium salt. (Byrne-Wisc) W68-00856

PHOSPHORUS RADIOACTIVE AND EXCHANGE OF LAKE NUTRIENTS, F. R. Hayes, and C. C. Coffin. Endeavour, Vol 10, pp 78-81, 1951. 4 p, 3 fig, 8

Descriptors: *Eutrophication, *Lakes, Acid lakes, Bibliographies, *Phosphorus radioisotope, On-site data collections, Fishes, Plankton, Algae, Frogs, Mosses, Hypolimnion, Thermocline, exchange, Water circulation, Nutrient absorption, *Chemical properties, Epilmnion, Bottom sedi-

The author's conclude from field experiments that the distribution of ions in water takes place far more rapidly (from 10-100 times) than previously supposed, and that the removal of materials from the waters does not take place separately, but perhaps is an exchange with substances in contact with the water. Phosphorus 32 was added first to the epilimnion of a highly stratified acid-bog lake less than 1 ac in area and 22 ft in depth. The uptake by zooplankton, sponges, sphagnum, and algae was immediate; fishes, Fundulus, and Notemigonus showed no measurable uptake for several days, suggesting that their intake was by feeding on plank-ton; no evidence was found that the additive ton; no evidence was found that the additive reached the hypolimnion. Certain plants can concentrate phosphorus up to 40,000 times its concentration in the surrounding water. In the second experiment, the tracer was added to the hypolimnion of the same lake. The isotope moved no more than 5 mph through the cold bottom water and the movement was largely lateral. An 8-ac primitive lake, with little vegetation and no sphagnum, was the site for the third experiment. Its waters were completely mixed from top to bottom. The tracer was added at the surface, and the surface and bottom waters, bottom sediments, and plants quickly reached equilbrium. (Byrne-Wisc) W68-00857

ON THE KINETICS OF PHOSPHORUS EXCHANGE IN LAKES,

Dalhousie Univ., Nova Scotia, Canada. F. R. Hayes, J. A. McCarter, M. L. Cameron, and D. A. Livingstone.

J Ecol. Vol 40, pp 202-216, 1952, 15 p, 7 fig, 2 tab.

*Eutrophication, Oligotrophic, *Lakes, *Phosphorus radioisotope, *Turnovers, Nutrients, Phosphorus, Influent sewage, Equilibrium, Mathematical models, On-site data collections, Bottom sediments, Bibliographies, Absorption, Fishes, Algae.

Any single or periodic application of a fertilizer is not likely to have any more than a brief effect on the waters to which it was applied, however great its quantity. This conclusion was reached from studies of the data collected after phosphorus 32 was added to the water of a small lake near Halifax, Nova Scotia. The tracer was rapidly lost by uptake by aquatic organisms and bottom sediments (mud). The added phosphorus increased the normal water content by only 0.25%. The active exchange of the phosphorus radioisotope and the phosphorus in the lake organisms and bottom sediments soon became a single equilibrium system. The turnover time for phosphorus in the water was 5.4 days, and that for the phosphorus in organisms and mud was 39 days. Only the superficial layer 1 mm thick was involved in the interchange. Eutrophication can be induced by the constant addition of sewage to a lake; this keeps the nutrients continuously above the equilibrium level for organisms and muds. Stoppage of sewage discharge would lower the phosphorus level and the lake would become oligotrophic. (Byrne-Wisc) W68-00858

ANTIBIOTIC ASPECTS OF COPPER TREAT-MENT OF LAKES, Wisconsin Univ., Department of Zoology.

Arthur D. Hasler. Trans Wisconsin Acad of Sci, Arts and Letters, Vol 39, pp 97-103, 1949. 7 p, 18 ref.

Descriptors: *Eutrophication, *Lakes, *Copper sulfate, *Algal control, *Toxins, Algae, Resistance, Fish, Amphibians, Invertebrates, Aquatic popula-tions Bibliographies, Bottom sediments, tions, Bibliographies, Bottom sediments, Watershed management, Harvesting of algae, Water zoning. Identifiers: Physiological effects.

Lakes, in a comparatively short time, move toward a eutrophic stage in which massive algal developments may be anticipated. Such algal growths inhibit many of the recreational and other human uses made of the lakes and of their waters. The spray application of copper sulfate solution has been found effective in inhibiting the development of algal blooms. However, the addition of copper through sprays may introduce a toxic condition. The results of short exposures of fish to copper salt toxicity do not reflect the impact of toxic effects over longer periods. Algae, fish, invertebrates, and amphibians are all subject to inhibition or destruction by the absorption of copper salts. The author suggests that studies be undertaken to substitute other control substances for a permanent poison that has been employed to combat a temporary nuisance. Harvesting of crops of algae and large aquatic plants might be a control mechanism, as might zoning of lakes for certain specific uses, and various kinds of watershed controls. (Byrne-Wisc) W68-00859

LIMNOLOGICAL STUDIES IN CONNECTICUT.
7. A CRITICAL EXAMINATION OF THE SUPPOSED RELATIONSHIP BETWEEN PHYTOPLANKTON PERIODICITY AND CHEMICAL CHANGES IN LAKE WATERS, Yale Univ., Osborn Zool Lab. G. Evelyn Hutchinson.

Ecol, Vol 25, No 1, pp 3-26, Jan 1944, 24 p, 6 fig, 37 ref.

Descriptors: *Eutrophication, *Lakes, Phytoplankton, Algae, Seasonal, Cyanophyta, *Inorganic compounds, Phosphorus, Bibliographies, Nitrates, Nutrients, Phosphates, Silicates, Iron oxides, *Plant populations, Reviews, Light intensity, Water temperature, Diatoms, Chlorophyta. Identifiers: Desmids.

As the result of his studies of Linsley Pond, a small lake in Conn, the author concludes that there is in general, no clear cut correlation between the chemical condition of the water and the qualitative composition of the phytoplankton. The physiological condition of a population and its relation to populations of other species is likely to explain many of the apparent inconsistencies between the seasons and different lakes. The springtime appearance of Dynobryon divergens in Linsley Pond is to be correlated with a rise in the ratio of nitrate to phosphate, but is independent of variations in soluble silicate. Invariably the Dynobryon popula-tion seems to increase after the major components of the spring maximum have declined. The pond gives no evidence that the appearance of Asterionella formosa depends on the level of inorganic nutrition. The blue-green algal blooms of late summer arise when the inorganic nutrients are practically exhausted. In small eutrophic lakes, all of the inorganic nutrients, except phosphorus and combined nitrogen, are normally present in great excess. As for iron, only particulate ferric iron is likely to be important. (Byrne-Wisc) W68-00860

THE ECONOMICS OF WATER UTILIZATION IN THE BEET SUGAR INDUSTRY, George O. G. Lof, and Allen V. Kneese

Johns Hopkins Press for Resources For the Future, pp 125, 1968.

Descriptors: Economics, *Economic efficiency, Water pollution control, Sugar beet plants, *Sugar beets, Industrial production costs, *Industrial wastes, *Wastewater reclamation. Identifiers: Economics of pollution control, Sugar beet processing.

A single average plant of the 58 plants in the beet sugar industry produces gross wastes equivalent to raw domestic sewage from a population of 270,000. The elimination of remaining waste from the industry wastewater could be accomplished at a cost of \$5,000,000 annually by recirculation of process water and its attendant treatment, pulp drying, modern methods of processing 'Steffens Waste' and re-use of 'condenser water' as well as by Waste and re-use of 'condenser water' as well as by specific waste treatment processes. However, the incremental costs of removing pollution would gradually increase from \$1 to \$90 per unit removed. The authors make three main points: (a) further research is necessary to achieve improved biologic treatment of beet sugar plant wastes, (b) projections of water and waste loads which are wade by applying coefficients based upon present. made by applying coefficients based upon present technology to projected industrial production are not reliable, and (c) economic incentives offered industrial firms to treat their wastes (as by tax abatement) may lead to grossly inefficient resource utilization, since process change may be a better way of handling the problem. The latter two points are of general application in the field of industrial waste treatment. (Whipple-Rutgers)

ECOLOGICAL STUDY OF THE EFFECTS OF STRIP MINING ON THE MICROBIOLOGY OF STREAMS,

Kentucky Univ., Lexington.
Harry D. Nash, and Ralph H. Weaver.
Research Report 18, Kentucky Water Resources
Inst., Lexington, 1968. 35 p. 19 tab.

Descriptors: Strip mines, Drainage, Ferrobacillus, Water temperature, Hydrogen ion concentration, Fungi, Yeasts, Pyrite, Algae, Cyanophyta, Domi-nant organism, Nutrients, Rainfall-runoff relationships, Geographical regions, Kentucky, Acid streams, Microflora. Identifiers: Taxonomic groups, Molecular filter, Chemosynthetic, Saprophytic, Plate count, Fila-mentous, Unicellular, Natural recovery.

The microflora of Cane Branch of Beaver Creek in McCreary County, Kentucky, which drains an area that was strip-mined between 1955 and 1959, was studied and compared with that of Helton Branch which drains a comparable area where there has been no mining. Differences include: the establishment of Ferrobacillus ferrooxidans, for which procedures were developed for direct colony isolation from the stream; fewer saprophytic bacteria; more numerous and more diversified filamentous and unicellular fungi; and characteristic differences in algal flora. Representatives of 42 genera of filamentous fungi were identified. Of these, 21 were isolated only from Cane Branch. Representatives of five genera of unicellular fungi were found. One, Rhodotorula, was found consistently in Cane Branch but never in Helton Branch. From 1966 to 1968, Bumilleria appears to have established itself as the dominate alga in Cane Branch at some distance downstream from the strip-mine drainage area. Seasonal differences in the microflora appear to be relatively insignificant, except for the algae. (Author) W68-00891

A STUDY OF ENERGY FLOW THROUGH SELECTED COMPONENTS OF A SMALL AQUATIC ECOSYSTEM.

Georgia Univ., Athens.

Donald C. Scott, Harold E. Welch, Jr., and John A. Holbrook, II.

Completion Report for Office of Water Resources Research, Aug 1968, 161 p, 24 fig, 35 tab, 106 ref (Ph.D. and M.S. theses, preface and abstracts bound in one volume). Project B-007-GA.

Descriptors: *Aquatic ecosystem, *Energy budget, *Aquatic productivity, *Food chains, *Fish food organisms, Standing crops, *Trophic level, Benthic animals, Benthic diptera, Lake morphometry, Photosynthesis, Herbivores, Carnivores, Photosynthesis, Phytoplankton, Fish populations, Organic productivity, Insect growth, Fish predation, Crustaceans. Identifiers: Lago Lake, Athans, Ga., Weiberg equation, Lindeman's premise, Odum and Wiegert equation, Krogh curve, Schnabel Method.

Primary production and energy flow through two major food chains were measured in a small fertilized Georgia farm pond. Gross photosynthesis was estimated by a modified diurnal oxygen curve method. The dominant herbivores were midge larvae and small crustacea. The crustacea-Chaoborus food chain accounted for 37% of all herbivore growth and competed with the herbivore-centrarchid food chain. The energetics of bass and young bream correspond closely to the generalized equation used by Winberg, but growth efficiencies of older bream were less than predicted. Yield efficiencies were similar at each trophic level. Herbivores had much higher net growth efficiencies, corroborating Lindeman's premise that carnivores expend more energy for maintenance and less for growth than do herbivores. Five methods of capture, trapping, angling, shocking and seining (two types), with individual marking of each fish were used in estimating fish population. Homing and territoriality appear important in assessing recapture data. Bioenergetic studies were estimated from pooling data of all types of capture. Results of the research are contained in a Ph.D. thesis and a M.S. thesis bound in one volume. (Authors) W68-00901

EUTROPHICATION OF FLORIDA LAKES,

Eutrophication Of Florida Water **FACTORS** AFFECTING ACCELERATED

Florida Univ., Gainesville, Florida Resources Research Center. For primary bibliographic entry see Field 02H.

For abstract, see W68-00912

THE MICRODISTRIBUTION OF STREAM BENTHOS

Pittsburgh Univ., Pittsburgh. For primary bibliographic entry see Field 02H For abstract see W68-00914

STREAM POLLUTION - RIGHTS OF RIPARIAN LANDOWNER.

Charles K. Pringle

Miss L J, Vol 26, No 1, pp 106-108, Dec 1954. 3 p,

Descriptors: *Riparian rights, *Reasonable use, Water pollution, Relative rights, Judicial decisions, *Mississippi, Riparian land, Damages. Identifiers: Procedure (Legal aspects).

This is a comment on the Mississippi case of Southland Co v Aaron. Defendant non-negligently polluted a creek with salt and oil, which subsequently injured plaintiff's undeveloped riparian land. The complaint alleged negligence, but when this was not proven, the court allowed recovery on the basis of nuisance. The measure of damages was the diminution in rental value of plaintiff's land to the extent that it was caused by defendant's action. The comment points out that the great contrast of interests between parties was ignored, and it appears from this case that Mississippi will not apply the 'reasonable use' doctrine exception to common law riparian rights. It is concluded that this holding amounts to strict liability. (Williams-Fla) W68-00927

STREAM POLLUTION - RECOVERY OF DAMAGES.

Iowa L Rev, Vol 50, No 1, pp 141-157, Fall 1964. 17 p, 111 ref.

Descriptors: *Water pollution, Reasonable use, Natural flow doctrine, Riparian rights, Relative rights, Legal aspects, Judicial decisions, Damages, Compensation.

Tort recovery for the unreasonable interference with interest in the use and enjoyment of land and accompanying water rights is usually based upon the law of nuisance. Under the natural flow theory any change in natural conditions or characteristics of water is actionable by the riparian owner, while under the reasonable use theory only unreasonable uses of water are actionable. Defenses to a pollution suit which are often raised are the statute of limitations, prescription, easement, and agreement. Under the natural flow theory the statute of limitations begin to run as soon as an unprivileged use commences regardless of whether there are damages, and can result in injustice. Under the reasonable use theory the statute does not begin to run until the use becomes unreasonable. The extent of recovery for damage to land or water depends upon whether the damages are permanent or temporary. Tort liability has been an ineffective measure for controlling pollution, but is complementary to statutory controls, and provides compensation to the individual for resulting injuries. (Smith-Fla) W68-00932

RECENT STUDIES ON THE ROLE MICROORGANISMS IN THE CYCLING OF SUBSTANCES IN LAKES,

Academy of Science of USSR, Inst. of Microbiolo-

gy, Moscow. S. I. Kuznetsov

Limnol and Oceanogr, Vol 13, No 2, pp 211-224, April 1968. 14 p, 11 fig, 6 tab, 23 ref.

Descriptors: *Microorganisms, *Lakes, *Aquatic bacteria, Biomass, Nitrogen fixation, Decomposing organic matter, Photosynthesis. Identifiers: *Conversion cycles, *Benthic waters, *USSR, Cycling of elements.

In a review of Soviet Union research on the ecology of aquatic bacteria, an evaluation was attempted of the conversion rates in reservoirs as well as of the cycles of several chemical elements related to the activity of specific microorganisms. Revealed is an increasing emphasis on in situ measurements of the rate or extent of conversion of carbon, nitrogen, sulfur, and iron from one form to another and on the bacteria responsible for these conversions. Theoretical considerations and results of several studies are summarized. These include measurement of bacterial biomass production and nitrogen fixation with isotopes, factors affecting decomposition of water humus in bog lakes, annual succession of iron bacteria in relation to the cycling of iron, nitrogen exchange between bottom sediment and benthic waters, the concept and calculation of nitrogen balance in a lake, and the bacteria responsible for the oxidation of sulfur. An attempt is made to incorporate this information into flow diagrams showing the dynamics of the cycling of the 4 elements discussed. (Llaverias-USGS) W68-00946

CHARACTERIZATION OF PHOTOSYNTHETIC SULFUR BACTERIA CAUSING RED WATER IN LAKE FARO (MESSINA, SICILY), Woods Hole Oceanogr Inst. Woods Hole, Mass, and Inst di Idrobiologia e Pescicoltura, Messina,

For primary bibliographic entry see Field 02H. For abstract, see W68-00950

BACTERIAL CAROTENOIDS FROM FRESH-WATER SEDIMENTS, Queen's University, Kingston, Ontario, Depart-

ment of Biology.
For primary bibliographic entry see Field 02H. For abstract, see W68-00951

5D. Waste Treatment Processes

PRECIPITATION CHEMICAL PHOSPHORUS IN A HIGH-RATE ACTIVATED

SLUDGE SYSTEM, W. A. Eberhardt, and J. B. Nesbitt. Jour Water Poll Control Fed, Vol 40, No 7, pp 1239-1267, July 1968. 29 p, 20 tab, 13 fig, 47 ref.

Descriptors: Biochemical oxygen demand, Performance, Phosphates, Phosphorus, Precipitation, Efficiency, Sewage treatment

Identifiers: Activated sludge processes, Chemical removal (Sewage treatment).

A biological-chemical process based on a high-rate activated sludge system offers high BOD removals and high removal of phosphorus. In bench-scale pilot studies with both synthetic and domestic wastewater, 60 1/day were treated under completemixing conditions for a theoretical aeration time of 2.7 hr, including detention in an air-agitated chemical mixing basin. Solids were separated in a clarifier and returned to the aeration basin; excess sludge Phosphorus, wasted semicontinously. was precipitated by aluminum sulfate added to the mixed liquor, is settled, returned, and wasted with sludge. The process can produce effluent residuals of less than 2 mg PO sub 4/1 (unfiltered) and 0.05 mg PO sub 4/1 (filtered) total phosphate and 20 mg BOD sub 5/1 with influent having 39.1 mg PO sub 4/1, 260 mg BOD sub 5/1 and a loading of 146 lb BOD/day/1,000 cu ft (2,340g/day/cu m). Aluminum sulfate dosage was 335 mg/1. W68-00677 precipitated by aluminum sulfate added to the

THE NATURAL CYCLE OF WATER REUSE, Water Resources Res Center, Univ. of Mass., Amherst, Mass

Bernard B. Berger. Water and Wastes Eng, Vol 5, No 8, pp 34-37, Aug 1968. 4 p, 2 fig, 3 tab, 16 ref.

Field 05 - WATER QUALITY MANAGEMENT AND PROTECTION

Group 5D - Waste Treatment Processes

Descriptors: *Water reuse, *Biodegradation, *Industrial wastes, Oil wastes, Pesticides, Recirculated water, Reclaimed water, Sewage treatment, En-

vironmental sanitation.
Identifiers: *Natural reuse cycle, FWPCA.

The problems and policies concerning natural-cycle reuse of water are briefly reviewed. The natural cycle does not destroy all industrial organic pol-lutants, like the pesticides, that are resistant to microbial attack. Detergents and oils are also long-lasting problems. Overloading the self-purifying capacity of a stream with degradable pollution increases the work downstream reusers must perform to use water. Even with advanced water-supply treatment, the problem of damage to fish and other aquatic life remains. Expansion of the population is expected to make even complete secondary treatment of all waste inadequate by 1980. Increased production of industrial wastes makes the situation worse yet. Bacterial and viral contamination as well as high nutrient contents of waters must be treated more effectively than at present. Federal policy is no standard that allows any untreated waste discharges. (Knapp-USGS) W68-00828 to prevent any further degradation and to approve

A GENERAL PLAN FOR THE DEVELOPMENT OF THE RESEARCH TRIANGLE REGION AS WASTE DISPOSAL AND AFFECTED BY WATER RESOURCES.

Research Triangle Regional Planning Commission, Raleigh, North Carolina.

Research Triangle Regional Planning Commission, Raleigh, N. C., June 1962, 140 p, 3 maps, 13 tables,

Descriptors: *Water resource development, *Urbanization, Water distribution, Water supply, *Priorities, Watersheds, Aerobic treatment, *Popula-

Identifiers: Raleigh, North Carolina, Neuse River Basin, Cape Fear River Basin, Orange County, N.C., Durham County, N.C., Wake County, N.C.

The region is roughly bisected by the drainage divide between the Cape Fear and the Neuse River basins, and separated into two entirely separate drainage areas. A major problem in the region is the lack of capacity of the region's streams for assimilation of the effluent from sewage treatment plants. An assumption is made of a total urban population of 600,000, but that number is not assigned to any date. Water resource development in the region has not been sufficient to provide for any appreciable portion of this projected growth. Four major projects are proposed: 3 dams and a large flood control structure at the Falls of the Neuse. These projects will be staged to meet regional needs and uses, and priorities assigned and modified as the level of the developed resources grow, or as other sources become available. The study also proposes certain public policies; namely, the establishment of a regional water resource agency by two or more local governments; putting in of the principal elements of sewerage systems in advance of development; provision for major raw water transmission lines; and a requirement that all subdivisions be either connected to public or group water and sewerage systems or have very large lots. (Starr-Chicago) W68-00846

THE ORSANCO STORY,

Resources for the Future. Edward J. Cleary. Resources for the Future, 1967, 335 p, 10 fig, 11 appendices Johns Hopkins Press.

Descriptors: *Water pollution, Interstate commissions, Interstate compacts, Water resource development, Bodies of water, Monitoring, Wastes, Water quality, Valleys. Identifiers: Ohio River Valley, Resources for the Future, ORSANCO.

This study is an account of the Ohio River Valley Water Sanitation Commission (ORSANCO) since its founding in 1948. The Commission is an example of an interstate agency created to deal with the complex problems of a regional nature, and the study relates why and how it came into being, what was done under its auspices and suggests what its future role might be. The major portion of its work has been done in the area of water pollution, and toward its goal of cleaning up the Ohio River Valley, it has established waste control policies and instituted river-quality surveillance and robot monitoring. It has also pioneered in methods of gaining support for its policies from both the public and private sectors. This study advances the proposi-tion that the influence and tasks of the interstate agency as an instrumentality for regional management of river quality should be expanded to include total water-resources planning and cites the Delaware River Basin Compact as its precedent for the establishment of such an agency. (Starr-Chicago) W68-00847

BIOLOGICAL REMOVAL OF NUTRIENTS FROM TREATED SEWAGE: LABORATORY EXPERIMENTS. Wisconsin Univ.

G. P. Fitzgerald, and G. A. Rohlich. Verh Inter Ver Limnol, Vol 15, pp 597-608, 1964. 12 p, 3 fig, 2 tab, 26 ref.

Descriptors: *Eutrophication, Laboratory tests, Biological treatment, Bibliographies, Chlorella, *Sewage, Effluents, Carbon Dioxide, *Algae, *Hydrogen ion concentration, Phosphorus, Nitrogen, Growth rates, Stabilization ponds, Sewage disposal.

The authors demonstrated by laboratory tests that in a relatively short period of time (13 days) the nutritional value of treated sewages, both secondary effluent and stabilization pond waters, was more closely related to the amounts of ammonia nitrogen than to phosphate phosphorus. Their studies showed that the type and quantity of algal growth attained in a stabilization pond will be controlled by the enviornment. 1% inoculations from lake waters with varied algal populations into stabilization pond water had no apparent effect on later growth of the algae. The experiments indicated that the rate of nutrient utilization and growth of Chlorella in primary or secondary effluents appears to be independent of the organic matter present. Because the carbon dioxide present effects pH of the sewage, the carbon dioxide used by results in higher pH values and in the considerable loss of soluble phosphate phosphorus in the medium. The precipitated phosphorus can be redissolved when the pH of the medium decreases. (Byrne-Wisc) W68-00855

QUALITY MANAGEMENT PLANNING OF ECONOMICALLY OPTIMAL POLLUTION CONTROL SYSTEMS,

Univ. of Michigan, Ann Arbor.

Rolf A. Deininger.
Proc First Annu Meeting Amer Water Resources
Ass. Univ of Chicago, pp 254-282, Dec 1965. 29 p,
3 fig, 4 tab, 25 ref, I append.

Descriptors: Biochemical oxygen demand, Computer programs, Water policy, Dissolved oxygen, *Economic efficiency, Flow augmentation, *Economic efficiency, Flow augmentation, *Linear programming, Optimization, Stream im-provement, Water quality control, *Water pollution control, Water management (Applied), Stan-

Identifiers: *Integer programming, Dual variables.

Linear programming and integer programming water quality models were structured and solved to determine optimal solutions for stream pollution control under three policies. The three policies compared were: (1) uniform treatment at all wastewater treatment plants; (2) max possible waste-

water discharge without violation of stream quality standards; and (3) a total minimum cost policy. The linear programming model was applied to a hypothetical example. Using the above three policy constraints, the results for various BOD pollution limits were compared. The min cost method was repeated and compared using integer programming, allowing treatment at only limited integer percentages. The use of the dual variable in defining the value of lowering binding quality constraints was discussed. The reduction in treatment costs resulting from flow augmentation was computed and shown. The effect of adding further quality constraints was discussed. (Gysi-Cornell) W68-00873

THE POLLUTION CONTROL MODELS AND THEIR RESULTS,

Harvard Univ, Cambridge, Mass. Grant W. Schaumburg, Jr. Water Pollut Contr in the Delaware Estuary, Harvard Water Program, Chapt IV, pp 74-150, May 1967. 77 p, 5 fig, 7 tab, 23 ref.

Descriptors: Biochemical oxygen demand, Constraints, Comparative benefits, *Comparative costs, Digital computers, Dissolved oxygen, Economic efficiency, Equitable apportionment, *Linear programming, Estuaries, Oxygen requirements, Stream improvement, Waste water treat-ment, *Water pollution control, Water policy, Zon-

Identifiers: Uniform treatment, Zoned uniform treatment, Least cost method, Effluent charge,

Delaware Estuary.

Linear programming models were presented minimizing the cost of several types of water pollution control schemes for the Delaware Estuary. The following types of pollution abatement schemes were compared: (1) Required Treatment (secondary); (2) Uniform Treatment; (3) The Least Cost Method; (4) Zoned Uniform Treatment; (5) Uniform Treatment Taking Past Removals into Account; and (6) The Effluent Charge System. Methods (2), (3), (4), and (6) were directly compared for several levels of estuary quality (DO level). The equity considerations of all the schemes were discussed, and tabled for comparison. (Gysi-Cornell) W68-00877

COMPUTER MODELS OF WASTE-WATER COLLECTION SYSTEMS, Harvard Univ, Cambridge, Mass.

For primary bibliographic entry see Field 06A. For abstract, see W68-00878

MATHEMATICAL MODEL FOR WATER POL-LUTION CONTROL STUDIES,

Northeastern Univ, Boston, Mass; New York Univ,

Alvin S. Goodman, and William E. Dobbins. Amer Soc Civil Eng Proc, Vol 92, No SA 6, pp 1-19, Dec 1966. 19 p, 4 fig, 5 tab, 6 ref.

Descriptors: *Water pollution control, *Biochemical oxygen demand, *Digital computers, Economic efficiency, Estimated benefits, Estimated costs, *Mathematical models, Computer models, Project planning, River systems, *Dissolved oxygen, Analysis of the control o nual, Sewage treatment. Identifiers: Massachusetts.

A methodology was presented for studying the physical, economic, and administrative interrelationships of water pollution control programs. It featured a mathematical model for a hypothetical stretch of river. The 'community and river model' was called CARM-1. A computer program, written in Fortran II, contained equations for river characthe Fortran II, contained equations for river characteristics (e.g. flow, time, BOD, DO) community characteristics (e.g. supplies, demands, costs, benefits, discharges, BOD, DO, coliforms). The program was comprised of three components: (1) statements to control data processing; (2) equations for CARM; and (3) statements for an 'op-timizing routine'. The input sets assumed various levels of treatment at 10 percent increments of BOD removed for the various plants. Results were graphed for the nine sections of river studied. The optimizing routine, based on the 'path of steepest accent', had some limitations. Modifications, such as assuming primary treatment at all plants, were recommended. It was concluded that basin costs can be lowered if uniform treatment is not required at all plants. (Gysi-Cornell) W68-00881

FOAM FRACTIONATION WITH REFLUX,

Cincinnati Univ., Ohio.

Robert Lemlich

Fed Water Poll Control Admin., U.S. Dept. Interior, Progress Report WP-00161, Dec. 1, 1966 - May 15, 1968. (A composite of 5 published papers plus 1 unpublished section.)

Descriptors: *Foam fractionation, Separation techniques, Foaming, Detergents, Surfactants, Water purification, *Foam separation, Flotation, Waste water treatment, Sewage treatment.

Identifiers: *Foam coalescence, Surface viscosity, *Bubble fractionation, *Adsorptive bubble separation methods, *Adsubble methods.

Drainage and coalescence were measured within a vertical foam fractionation column by means of electrical conductivity cells mounted internally at various levels. Changes in bubble size were measured photographically. Surfactants included (in turn) Triton X-100, albumin, and saponin, in water. Reflux ratios ranged from zero to infinity. Results showed that coalescence decreased and overflow increased as gas rate and concentration increased. A higher surface viscosity increased the foam stability. Combining experimental results with the author's established theory for foam drainage and overflow, reveals apparent non-Newtonian behavior at higher surface viscosity. Also, new theory was developed for the increased separation obtainable by bubble fractionation; i.e., by vertically elongating the liquid pool so as to establish a concentration gradient within it. (Author) W68-00899

PHOSPHOROUS REMOVAL IN WASTEWATER BY A MODIFIED ACTIVATED SLUDGE PROCESS,

Pilot Plant, Engineering Dept., City of Trenton,

Michigan. T. L. Hennessey, K. V. Maki, and E. Y. Young. Paper XV presented at Phosphorus Removal Workshop Second Session Chicago, Illinois - June 26-27, 1968. 19 pp, 6 fig, 3 tab.

Descriptors: Water pollution control, *Water pollution sources, Abatement, Eutrophication, *Activated sludge, *Phosphates, *Absorption, *Hydrogen ion concentration, Treatment facilities.

Oxygen requirements, Flocculation, Chemical precipitation.
Identifiers: *Hydrogen ion concentration, Absorption, *Activated sludge, *Eutrophication, *Phosphates, *Waste treatment, Biocontrol.

A 10 gpm pilot plant was installed at the City of Trenton to demonstrate phosphorus removal using a biological system. Results obtained at the San Antonio Plant were used as a guide to determine optimum operating conditions and included: (1) Aeration time and quantity of air supplied; (2) Concentration of mixed liquor suspended solids; (3) Concentration of dissolved oxygen in the aerator. A six-month trial period showed that phosphorus removal could not be achieved by any combination of these parameters. Both anaerobic and acid stripping of the 'saturated' return sludge, as reported by Levin, were then investigated. The time required to reach release levels of phosphorus by the anaerobic process as compared with the levels attained by batch acid stripping was excessive, so a continuous acid-stripping process was put

into operation. 66 deg. sulfuric acid is used to maintain the pH in the stripping tank between 4 and 5, which results in release of stored phosphorus. The stripped sludge is elutriated and returned to the aerator where the dissolved oxygen concentration is maintained between 4 and 6 ppm. Bacterial viability remains good above pH 4. Results obtained thus far show phosphorus removals of 50-70%, but with modifications, 80% removal is projected. (Maki-City of Trenton) W68-00909

5E. Ultimate Disposal of Wastes

DESIGN OF WASTE DISPOSAL WELLS.

Ground Water Associates, Norman, Okla. John H. Marsh.

Ground Water, Vol 6, No 2, pp 4-8, Mar-Apr 1968. 5 p, 6 fig, 3 ref.

Descriptors: *Injection wells, *Waste disposal, Industrial wastes, *Water pollution control, Water wells, Well casings, Corrosion, *Well screens, Wells, Well casings, Collosion, Well screens, Porilling fluids, Logging (Recording), Pressure head, Rotary drilling, Liquid wastes.

Identifiers: Disposal well completion methods, Cas-

ing perforation, Gravel packing, Corrosion-resistant tubing, Corrosion-resistant screening.

Basic design principles for disposal wells are presented, and 2 recently constructed wells for disposal of very corrosive refinery waste are described. Many disposal wells are constructed using oil well completion techniques which are greatly inferior to modern water well technique, for disposal-well purposes. Oil well drilling with bentonite mud tends to plug pores, and the common practice of cementing casing and gun per-forating the selected disposal interval provides insufficient area for efficient outflow. Drilling with organic mud which breaks down after use and the setting of screen instead of perforated casing greatly enhances the access of fluids to the injection zone. Design requirements for disposal wells are the same as for water wells with the additional considerations of aquifer protection by selection of a zone bounded by aquicludes, positive sealing of casing through the aquiclude, protection of casing from the fluid in the injection string, preventing clogging by precipitates or sediment, and use of screen with enough opening area to keep flow rate under 0.05 ft per sec. (Knapp-USGS) W68-00659

DEEP INJECTION WELLS.

Water Well J, Vol 22, No 8, pp 12-13, Aug 1968. 2 p, I fig, I tab.

Descriptors: *Waste water disposal, *Injection wells, Geologic formations, Injection, Industrial wastes, Chemical wastes.

Identifiers: *Injection rates, *Injection pressures, Injection well locations.

The information available on industrial waste injection wells is summarized. The data from 110 wells listed by FWPCA are analyzed. About 82% of the wells are used by chemical and pharmaceutical plants, refineries, natural gas plants, and metal product plants. The depth range is a few hundred to over 12,000 ft, but 64% are less than 4,000 and 92% are less than 6,000 feet deep. Injection is into unlithified sand in 33%, sandstone in 41%, and carbonates in 22%. Of the remaining 5, the Rocky Mountain Arsenal Well is in fractured Precambrian gneiss; a paper mill well is in fractured Precambrian gneiss and younger sandstones and carbonates; and 3 wells are injecting into evaporites. Injection rates vary from a few to over 900 gpm, with 34% less than 100 gpm and 78% less than 400 gpm. Existing injection systems are concentrated in the north-central and Gulf Coast areas. (Knapp-USGS)

HOW TO BURY A MAJOR POLLUTION PROBLEM.

Water Well J, Vol 22, No 8, p 20, Aug 1968. 1 p, 1

Descriptors: *Waste water disposal, *Injection wells, Geologic formations, Injection, Industrial wastes, Chemical wastes, Waste water, Treatment. Ohio

Identifiers: *Injection rates, Injection well construction.

An injection well is being constructed in Middletown. Ohio, to dispose of spent steel mill pickle liquor. The disposal horizon is the Mt. Simon sandstone, about 3000 ft deep, just above the Precambrian basement. The formation's porosity is 8 to 22%, and the disposal zone is 274 ft thick. The well will meet rigid state specifications to eliminate any contamination of usable groundwater. It is cased and cemented from the surface to the disposal zone. The surface casing is also cemented. Oil under higher-than-injection pressure will isolate the coated injection tubing from the casing to control accidental leakage. The pumps are made of corrosion-resistant titanium-palladium alloys. All sediment over 2-micron size will be removed from the waste before injection. The planned injection rate is 70 gpm, considerably below capacity. (K-napp-USGS) W68-00808

EMPIRICISM IN EXTERNALITIES AND WATER RESOURCES,

Economic Research Service, U S Dept. of Agriculture, Corvallis, Oregon. For primary bibliographic entry see Field 06B. For abstract, see W68-00888

SOME RELATIONSHIPS BETWEEN WATER POLLUTION AND INDUSTRIAL DEVELOP-MENT IN SOUTH CAROLINA, Clemson Univ., Clemson, S. C. Water Resources

Research Institute.

James M. Stepp.

Completion Report, OWRR Project No. A-002-SC. August 1968.

Descriptors: *Industrial wastes, *Waste water disposal, *Waste water treatment, *Canneries, Soil disposal fields, Lagoons, Cost comparisons, Benefits.

Identifiers: Manufacturing, South Carolina, Water use, Water pollution, Waste treatment, Cost,

There were four separable parts of this research project: (1) Compilation of data on water supply and utilization, amount and strength of effluent, wastewater disposal and treatment, employment, and local taxes paid for 135 wet-process South Carolina manufacturing plants. (2) Study of industrial wastewater treatment costs in South Carolina by applying hydrological, engineering and economic principles to readily-available data. (3) An engineering-economic analysis of alternative methods and costs of disposing of peach canning wastes. (4) A mail survey of industrial waste treatment by South Carolina municipalities. In terms of total volume of wastewater, BOD and suspended solids, the textile industry is the greatest industrial pollutor of South Carolina's waters, but the paper industry has a higher level of pollution per worker employed and per dollar of local taxes paid. The study of peach canneries indicated that the leastcost system of waste disposal under most of the conditions analyzed was spray irrigation of vegetation-covered land. (Author) W68-00895

Field 05-WATER QUALITY MANAGEMENT AND PROTECTION

Group 5F-Water Treatment and Quality Alteration

5F. Water Treatment and **Quality Alteration**

WATER QUALITY AND WASTE ASSIMILATIVE CAPACITY OF AN IMPOUNDMENT OF RECENT ORIGIN.

Clemson Univ., Clemson, S. C. Water Resources

Research Institute.

Alfred T. Wallace, and A. Ray Abernathy Termination Report for Project A-007-SC from the Water Resources Research Institute, Clemson University.

Descriptors: Water quality, *Self-purification, *Dispersion, Impoundments, Waste disposal, Reservoirs, Turbulence, *Organic matter, Dye releases.

Identifiers: Waste assimilative capacity, Dissolved organic matter, Hartwell Reservoir.

The capacity of a restricted portion of Hartwell Reservoir to assimilate treated domestic sewage was studied with regard to dispersion and reaeration. Wind action was found to be controlling. A mathematical analysis of dispersion in a turbulent basin was developed. Rhodamine WT and a Turner Fluorometer were used in field studies. 41 references included. A separate study was the evaluation of methods for quantitative analysis of dissolved organic matter in lake water. The method selected included vacuum concentration, freeze drying, and combustion analysis of the dry residue. 40 annotated references included. (Author) W68-00896

SEASONAL OBSERVATIONS OF LIMNOLOGICAL PARAMETERS IN A LARGE SOUTHEASTERN RESERVOIR,

Georgia Univ., Athens. Roger Barnhart, and Daniel Holder. Completion Report for Office of Water Resources Research Project B-002-GA.

Descriptors: *Hypolimnion, *Limnology, *Thermocline, *Zooplankton, *Cold-water fisheries, *Temperature, *Reservoir stratification, Epilimnion, Dissolved oxygen, Morphometry, Alkalinity, Water quality, Entrophication, Phytoplankton blooms, Chlorophyll 'a', Standing crop, Copepods, Rotifers, Plankton dynamics, Solar radiation. Identifiers: Georgia, Lake Sidney Lanier, Ga., Chattahoochee River, Chestatee River, Flat Creek Cove, Secchi disc transparency.

Study of the limnology of Lake Sidney Lanier, Georgia, from February 1966 to February 1967 indicates that the reservoir productivity is low. Analysis of the lake's oxygen and temperature characteristics indicates that inflowing rivers did not cause a density current to pass through the reservoir. The chemical stratification pattern of the lake results from the low productivity of the water and the cold hypolimnetic temperatures. During late summer stratification, a restricted zone of oxygenated water in the upper hypolim nion was suitable for the introduced trout fishery. Semi-uniform vertical distribution of chlorophyll 'a' content and net zooplankton were maximal in the lower epilimnion and upper metalimnion and decreased above and below these regions. Copepods were dominant during the late winter and early spring months; and rotifers were dominant during the spring and fall months. Continued pollution of the reservoir will speed up its eutrophication, leading to the detriment of the established trout fishery, to the decline of the other high quality sport fisheries, and to changes in the water color which will lower the aesthetic value of the reservoir. (WRC-Ga) W68-00903

INCREASED LEGAL SUPPORT FOR FLUORIDATION,

James A. Tobey. Public Works, Vol 96, No 10, pp 92-94, Oct 1965. 3 p, 11 ref.

Descriptors: *Fluoridation, *Judicial decisions, Legal aspects, Social aspects, Illinois, Michigan, Florida, Public health, Water supplies, Municipal water, Water purification, *Public water supply,

Identifiers: *Police power.

Court decisions dealing with the legality of fluoridation of public water supplies are examined. Fluoridation has been upheld as a valid exercise of the state police power by the courts of Final Appeal in 11 states. The U. S. Supreme Court has thus far refused to review any of these decisions. In Rogowski v City of Detroit, 347 Mich 408, 132 N W 2d 16 (1965), the plaintiff attacked the city's fluoridation ordinance on numerous grounds set forth in the article. The city introduced statements by public officials, scientific organizations, and professional associations as to the benefits of fluoridation. The court upheld the ordinance. Fluoridation cases in Illinois, Florida, Connecticut, and other states are discussed. The author concludes that fluoridation has been established as a valid and reasonable exercise of the police power by the state or its municipal agencies. (Kirkconnell-W68-00920

5G. Water Quality Control

REPORT OF THE COMMITTEE ON WATER QUALITY CRITERIA.

National Technical Advisory Committee on Water Quality Criteria.

Fed Water Pollut Contr Admin, U S Department of the Interior, Washington, D.C., 234 p., Apr 1, 1968. 7 fig, 51 tab, 473 ref, 2 append.

Descriptors: *Standards, Administration, Control, Governments, Specifications, *Water pollution, Water quality, Water utilization, Water quality act, Water quality control. Identifiers: *Water quality criteria, FWPCA.

Water quality criteria are established in accordance with the Water Pollution Control Act. The major water use categories for which criteria have been established are Recreational and Esthetics, Public Supply, Fish and Wildlife, Agricultural, and Industrial. Specific recommendations have been made for concentrations of all contaminants that affect each water use. The criteria are not based on maximum tolerable concentrations but on careful judgments of maximum desirable levels of contamination. Large safety factors are used when there is uncertainty of exact effects, for instance, in the tolerance of fish to insecticides or the possible biological accumulation of toxic agents in tolerant species used for food supply. (Knapp-USGS) W68-00656

WATER POLLUTION CONTROL,

Ohio State U, Columbus. Gwynne B. Myers. Ohio S L J, Vol 12, No 3, pp 376-380, Spring 1951. 5 p. 32 ref.

Descriptors: *Ohio, *Water pollution control, Pollution abatement, Legislation, Permits, Administrative agencies, Regulation, Legal aspects. Identifiers: Deddens' Act.

This is an analysis of the 'Deddens' Act', which is the first attempt to establish a comprehensive state program of water pollution control in Ohio. The Act is administered by the Water Pollution Control Board, which is made a part of the Department of Health. The Board has powers to investigate; issue, revoke, or modify orders, and establish and administer a permit system, among others. Violations of the provisions of the act are misdemeanors, and may also be enjoined. Definitions of pollution, waters of the state, and persons are broad in scope, while other frequently used terms are given their customary definition. Certain kinds of discharge are specifically exempted from the Act, and discharges of industrial wastes and acid mine drainage are exempted until the Board determines that there is a practical method for removing their polluting properties. All proceedings of the Board must be in accord with the provisions of the Administrative Procedure Act. (Smith-Fla)

OPTIMAL RELEASE SEQUENCES FOR WATER QUALITY CONTROL IN MULTIPLE-RESERVOIR SYSTEMS, Univ of Michigan, Ann Arbor; U. S. Dept of Interior, Office of Research Administration, Ann Arbor,

Norbert A. Jaworski, Walter J. Weber, Jr., and Rolf

Tech Publication, Joint Res Proj, Annapolis Sci Center, Fed Water Pollut Contr Admin, Apr 1968. 231 p. 34 fig. 20 tab, 90 ref, 5 append.

Descriptors: Biochemical oxygen demand, Computer programs, dissolved oxygen, *Dynamic programming, Economic efficiency, Mathematical models, *Optimization, Oxygen sag, Regulated flow, eservoir operation, River regulation, River systems, Simulation analysis, *Water quality, Con-

Identifiers: Potomac River Basin.

The problem of determining optimal flow releases for water quality control was structured as a converging branch, multistage dynamic programming model. The model had five options for determining optimal releases. They were (1) min DO deficit for a given BOD state; (2) min DO deficit; (3) leastcost reservoir storage for a given BOD stage; (4) least-cost reservoir storage; and (5) min BOD. Predictive algorithms for temperature, BOD, and DO, based on a modified Streeter-Phelps' equation, were incorporated in the model. A model was developed which provided mathematical linkage for the quality formulations and the dynamic program to the physical features of a basin. Optimal releases for proposed impoundments in the Potomac River basin were developed, and the sensitivity of the releases to various physical and biochemical, design and socio-economic parameters was investigated. Further developments of the model were suggested and extensive discussions and conclusions were presented. (Gysi-Cornell) W68-00863

RECENT RESULTS FROM A MATHEMATICAL MODEL OF WATER POLLUTION CONTROL IN THE DELAWARE ESTUARY, Dept of Health, Education and Welfare, Philadel-

phia, Pa. Robert V. Thomann.

Water Resources Res, Vol 1, No 3, pp 349-359, July-Sept 1965. 11 p, 4 fig, 1 tab, 4 ref.

Descriptors: Mathematical models, Oxygen sag, *Dissolved oxygen, *Standards, Input-output analysis, Biochemical oxygen demand, *Estuaries, *Water pollution control, *Linear programming, Digital computers, Economic efficiency, Sewage effluents, Sewage treatment, Stream improvement. Identifiers: Steady-state responses, sional model, Matrix, Delaware Estuary.

The basic concepts of systems analysis and optimum (least-cost) water pollution control were introduced. The input-transformation-output components of a system were illustrated by the development of a model based on the classical dissolved oxygen sag equation. Equations describing the time and space variability of DO were presented and their usefulness discussed. The application of the mathematical model to the control of DO in the Delaware Estuary was given. The estuary was divided into 30 reaches of 10-20,000 feet length each. An initial program was written which generated information on the input-output functions. Unit inputs were sequentially placed in each section of the estuary. The output consisted of a set of coefficients indicating how the inputs were

dispersed and transported up and down the estuary. second program incorporated the coefficients A second program incorporated the coefficients with marginal cost functions and DO goals to determine the least-cost pattern of waste removals. A study was made of the sensitivity of the optimal solution to the assumed atmospheric reaeration rate. (Gysi-Cornell) W68-00866

ECONOMIC EVALUATION OF FLOW AUG-MENTATION: A SYSTEMS ANALYSIS CASE

STUDY, Jerry R. Rogers, and Robert S. Gemmel. Proc 21st Ind Waste Conf, Part 1, pp 568-580, May 1966. 13 p, 1 fig, 6 tab, 5 ref.

Descriptors: Biochemical oxygen demand, Digital computers, Dissolved oxygen, Economic efficien-*Evaluation, *Flow augmentation, Hydrologic data, *Linear programming, Oxygen requirements, River systems, Standards, *Stream improvement, River systems, Standards, *Stream improvement, *Waste water treatment, Waste dilution, Water quality control.

Identifiers: Fox River Illinois, Dual simplex method.

Linear programming techniques were used to find the regional least cost solution for treatment facilities required to meet BOD and DO constraints on the Fox River in Illinois. Possible degrees of treatment were assumed to vary between 0-90%. DO was assumed to be a linear function of upstream waste additions. The dual simplex method of LP was adapted for use on a digital computer. Sample computer outputs were presented and discussed. The effects of various flow augmentations upon regional treatment costs during low flow periods were compared. Flow augmentation of 200-250 cfs was recommended. It was concluded that LP techniques could provide efficient analysis of complex river systems, but that careful determination of waste deoxigenation coefficients was required, since BOD and DO profiles were sensitive to those parameters. (Gysi-Cornell)

REGIONAL WATER QUALITY MANAGEMENT

- A PILOT STUDY, Carnegie Inst of Technology, Pittsburgh, Penn. Harold J. Day, F. Trenery Dolbear, Jr., and Morton

Proc First Annu Meeting Amer Water Resources Ass, Univ of Chicago, pp 283-309, Dec 1965. 27 p, 14 fig, 9 ref.

Descriptors: Biochemical oxygen demand, Dissolved oxygen, *Economic efficiency, *Linear proramming, Optimization, Steam improvement,
*Water quality control, Water management (Applied), Standards, *Regional analysis, Fixed costs,
River basin development.

Identifiers: Integer programming, Dual variables, Miami Basin, Ohio.

A study of the minimum cost attainment of water quality standards in Great Miami River Basin in Ohio was presented. A brief description of the hydrologic and economic aspects of the basin were given. A modified Streeter-Phelps oxygen sag model was used in constructing a linear promodel was used in constructing a linear pro-gramming problem for minimizing costs of achiev-ing quality standards, given the existing treatment facilities. The model used '0-1' programming to ac-count for the fixed charge aspects of installing treatment capacities, and integer programming to account for limited levels of allowable treatment. Results from this problem, incorporating data from the Miami, were presented and discussed. Long run pricing problems were outlined and potential basin-wide treatment techniques were listed and discussed. (Gysi-Cornell) W68-00870

WATER POLLUTION CONTROL USING BY-

PASS PIPING, Univ of California, Los Angeles. G. W. Graves, G. B. Hatfield, and A. Whinston.

Working Pap No 133, Western Manage Sci Inst, Univ of Calif, Los Angeles, Mar 1968. 59 p, 9 fig. 7 tab, 6 ref, 2 append.

Descriptors: *Linear programming, Digital compu-Descriptors: *Linear programming, Digital computers, Dissolved oxygen, Economic efficiency, Estuaries, Oxygen requirements, *Pipelines, Pumping, River systems, *Stream improvement, *Water pollution control, Waste water disposal, Water conveyance. Identifiers: Delaware Estuary, Generation of ele-

ments, *By-pass piping.

Linear programming techniques were used to find the least-cost by-pass piping solution for various polluters, when quality standards in several segpointers, when quality standards in several seg-ments of a river system were changed. A method for the solution of large scale linear programming problems was presented. It resorted to 'generation of elements' as needed, instead of carrying a complete simplex tableau and updating it in its entirety at each pivot. The method was applied to the solution of a by-pass piping problem for a small hypothetical river system, for illustrative purposes, and then applied to a larger real piping problem for the Delaware Estuary. The 84-mile estuary was seg-mented into 30 sections serving 44 waste discharges. Solutions for two DO minimum standard vectors were compared. It was concluded that by-pass piping appeared promising as a solution to water pollution problems, but that optimal solu-tions could only be obtained if sufficient reductions in DO levels were allowed in some sections. (Gysi-Cornell) W68-00872

WATER QUALITY STANDARDS,

Federal Water Pollution Control Administration. James L. Agee. J Amer. Water Works Assoc., Vol 59, No 12, pp 1501-1503, Dec 1967. 4 p.

Descriptors: *Water Quality Act, *Water pollution control, Water quality, Water pollution, Water pollution sources, Legislation, Federal government, Water law, Impaired water quality, Pollution abatement, Waste water treatment.
Identifiers: *FWPCA, *Interstate waters.

The Water Quality Act of 1965 required each state to submit to the Department of the Interior by June 30, 1967, water quality standards for interstate water. To assist the states in setting up these standards the FWPCA issued two documents in 1966-1967--'Guidelines For Establishing Water Quality Standards for Interstate Waters' and 'Necessary Supporting Material and Implementation Plan Contents.' This article briefly discusses four of the guidelines set out in these documents: (1) water quality standards should be designed to enhance the quality of water; (2) each plan should contain sufficient details on how the standards will be implemented and enforced; (3) each plan should in-clude all relevant sources of pollution; (4) all wastes draining into interstate waters which are amenable to treatment must be treated. As a part of the comprehensive water quality program the FWPCA has formed technical advisory committees on public water supplies, industrial water supplies, recreation, and fish and aquatic life to assist the states in setting up water quality standards. (Kirkconnell-Fla) W68-00917

THE FATE OF PESTICIDES APPLIED TO IRRIGATED AGRICULTURAL LAND,
State of California, Fresno, Department of Water

Resources.

Thomas A. Tamblyn. California Department of Water Resources Bulletin 174-1, May 1968, 30 p, 2 fig, 16 tab.

drainage, *Chlorinateu les, *Pesticide residues, *Tile Descriptors: hydrocarbon pesticides, *E *Leaching, *Pesticide kinetics.

The first two years of a study of the fate of pesticides are presented. The work was conducted on a

110-acre test plot in western Fresno County. The soil of the plot is Lethent silty clay loam, strong alkali. By applying DDT and Lindane to the plot, and measuring the chlorinated hydrocarbon pesticide content in and the quantities of the applied water, tailwater (surface runoff), tile drainage and soil, it was concluded (1) the pesticide content of the drainage is not significantly greater than that of the applied water when pesticides of low solubility are applied, (2) the concentration in tile drainage of a more soluble pesticide is significantly higher than that of the applied water, (3) the pesticide concentrations found in soil vary with time at a rate that is proportional to the concentration present. The rate of change is also influenced by moisture conditions of the soil environment. The nature of this variation indicates that some of the pesticides in the soil are decomposing in place, (4) effluent from tile drainage did not appear to remove an appreciable quantity of chlorinated hydrocarbonic material from the field, and (5) more pesticide is removed through decomposition in the soil than through leaching. (Beck-Calif) W68-00919

THE CLEAN RIVERS BILL: A CRITICAL REVIEW.

John E. Kinney.

Water and Sewage Works, Vol 113, No 4, pp 154-155, April 1966, 2 p.

Descriptors: *Federal government, *Legislation, Water pollution control, Water Resources Planning Act, *Administration, Administrative agencies, Water law, Legal aspects, Water policy, Political aspects, Water resources development, Water Quality Act. Identifiers: *Clean Rivers Bill.

The 1966 Clean Rivers Bill (S 2987 and HR 13104) is criticized on the grounds that it conflicts with the 1965 Water Resources Planning Act and the 1965 Water Quality Act. The Clean Rivers Bill attempts to over-centralize the administration of many local and area water pollution projects in the many local and area water pollution projects in the Secretary of the Interior, rather than allowing these problems to be dealt with as part of regional water resources planning projects. Ten specific criticism are leveled at the Bill, all in the general area of too much central control of problems which require local flexibility. The author suggests that this legislation would be detrimental to a workable federal program of water pollution control. (Kirkfederal program of water pollution control. (Kirk-connell-Fla) W68-00921

DURING FLOW IN 'DISPERSION HETEROGENEOUS POROUS MEDIA', Purdue Research Foundation, Lafayette.

Robert A. Greenkorn. Progress Report on Grant No. WP-01048-01 ESFA (1). Federal Water Pollution Control Administration, 1968.

Descriptors: *Dispersion, *Heterogeneity, Flow, Permeability, Pore pressure, *Anisotropic, Velocity, Statistical model. Equations, Identifiers: Longitudinal, Transverse, Glass beads, Tensor, *Non-uniform, Continuum theory.

Longitudinal dispersion coefficients were determined in four six-inch linear models each packed with different size glass beads. These four pieces were connected in four different arrangements and longitudinal dispersion determined for each arrangement. The results for the individual pieces rangement. The results for the introduction show a significant difference in dispersion coefficient with bead size or heterogeneity and in the exponent n of D=av to n power. The dispersion coefficient shows a significant change with rearrangement; however reverse flow for a given arrangement gives the same result. Breakthrough curves measured in a radial model packed with alternate layers of beads depend on direction. The parameters for a statistical model of a porous medium with non-uniform capillary pores were determined from capillary pressure, permeability, longitudinal, and

Field 05-WATER QUALITY MANAGEMENT AND PROTECTION

Group 5G-Water Quality Control

transverse dispersion measurements. The usual dispersion equation can be derived by volumeaveraging the transport equations, however, the dispersion tensor contrary to previous formulation for non-uniform, anistropic porous media contains both linear and quadratic velocity terms. In the coming year measurements of dispersion in heterogeneous, non-uniform, anistropic bead packs will be completed. Results will be used to improve the statistical and continuum theories. (Author) W68-00922

FUTURE DEVELOPMENT OF THE GROUND-WATER RESOURCE IN THE LOWER GREAT MIAMI RIVER VALLEY, OHIO--PROBLEMS AND ALTERNATIVE SOLUTIONS, U S Geological Survey.

For primary bibliographic entry see Field 04B For abstract, see . W68-00961

WATER AND WASTEWATER ENGINEERING, Harvard Univ, Johns Hopkins Univ, and Univ of N

For primary bibliographic entry see Field 03B. For abstract, see . W68-00966

INFILTRATION AND PERCOLATION STUDIES OF SULFIDES AND BONACEOUS MATTER, SEWAGE CAR-

Hawaii Univ, Honolulu. For primary bibliographic entry see Field 02G. For abstract, see . W68-01010

06. WATER RESOURCES **PLANNING**

6A. Techniques OF Planning

HYDROPOWER PROJECT OUTPUT OP-TIMIZATION,

California Univ., Berkeley For primary bibliographic entry see Field 08C. For abstract, see . W68-00862

OPTIMAL RELEASE SEQUENCES FOR WATER QUALITY CONTROL IN MULTIPLE-RESERVOIR SYSTEMS, Univ of Michigan, Ann Arbor; U. S. Dept of Interior, Office of Research Administration, Ann Arbor, Mich.

For primary bibliographic entry see Field 05G. For abstract, see. W68-00863

DISCUSSIONS OF PRELIMINARY OPTIMIZA-

TION OF AN AQUEDUCT ROUTE, Technion, Haifa, Israel; Univ of Michigan, Ann Arbor

Nathan Buras, and Rolf A. Deininger. Amer Soc Civil Eng Proc, Vol 91, No IR 4, pp 92-94, Dec 1965. 3 p, 5 ref.

Descriptors: *Aqueducts, Alternative costs, Dis-Descriptors: "Aqueducts, Alternative Cosa, Distribution systems, Dynamic programming, Economic efficiency, Estimated costs, *Future planning (Projected), *Hydraulic design, Mathematical models, Networks, *Optimization, Probability, Water conveyance, Water delivery, Water resources development.

Identifiers: Deterministic estimate, Probabilistic estimate.

Two discussions of an earlier paper on the 'Preliminary Optimization of an Aqueduct Route' were presented. The earlier paper had concluded that the optimum route across a plane would be a com-

bination of one 'lift' and one or two 'reaches'. The first discussion suggested that direct pumping from the lower to the upper extremity may be a third possible optimal solution. A mathematical model was presented which would check for that possibility. The second discussion suggested that rather than a simplified 'one source-one sink' system, a generalized multi-source and sink system might have been modelled. The structure of the general problem was given. A few examples of the general problem were referenced. It was also suggested that rather than choosing deterministic values for the estimated 'link' costs, probabilistic estimates as had been used in PERT networks, should be used. Finally it was mentioned that since water resources projects are characterized by changing imputs and outputs with time, the dynamic aspects of the model would be of interest. (Gysi-Cornell) W68-00864

FINDING RESERVOIR OPERATING RULES, Fed Water Pollut Contr Admin, U. S. Dept of the Interior, Washington, D. C. George K. Young, Jr.

Amer Soc Civil Eng Proc, Vol 93, No HY 6, pp 297-321, Nov 1967. 25 p, 2 fig, 4 tab, 26 ref.

Descriptors: *Reservoir operating, *Dynamic programming, Simulation analysis, Optimization, Queueing theory, Statistical models, *Monte Carlo method. Regression analysis, Least squares method.

Deterministic forward-looking dynamic programming was used with hydrologic simulation to find optimal reservoir operating rules. The objec-tive was to find the annual operating policy of a sin-gle reservoir such that the expected economic loss associated with each draft rate was minimized. A mathematical model was presented. Two loss func-tions were solved using the Monte Carlo scheme which arrived at estimated optimal policies using least square regression. Results were presented in tables. A hypothetical example was solved. The following inferences were made: (1) Markov correlation does not influence the time independent option does not influence the time independent op-timal policy; (2) the standard policy is not neces-sarily optimal for strictly convex, twice differentia-ble loss fn; (3) the standard policy is optimal for some piece-wise linear loss fn; and (4) forecasting can decrease quadratic losses but not piece-wise linear losses. (Gablinger-Cornell) W68-00865

RECENT RESULTS FROM A MATHEMATICAL MODEL OF WATER POLLUTION CONTROL IN THE DELAWARE ESTUARY, Dept of Health, Education and Welfare, Philadel-

phia, Pa. For primary bibliographic entry see Field 05G.

For abstract, see. W68-00866

A METHOD OF SCHEDULING OPTIMUM OPERATION OF ONTARIO HYDRO'S SIR ADAM BECK-NIAGARA GENERATING STA-

The Hydro-Electric Power Commission of Ontario, Toronto, Canada,

For primary bibliographic entry see Field 08C. For abstract, see . W68-00867

ECONOMIC EVALUATION OF FLOW AUG-MENTATION: A SYSTEMS ANALYSIS CASE STUDY,

For primary bibliographic entry see Field 05G. For abstract, see. W68-00868

EXPERIENCE WITH PRELIMINARY SYSTEM ANALYSIS FOR RIVER BASINS,

Massachusetts Inst of Technology, Cambridge. Ronald T. McLaughlin.

Pap, Int Conf Water for Peace, No P/408, May 1967. 12 p, 4 fig, 20 ref.

Descriptors: Constraints, Design criteria, *Linear programming, Hydrologic data, Mathematical models, *Project planning, *River basin development, *Systems analysis, Water resources development, Optimization, Planning, River basins, Reservoir design.

Identifiers: Sensitivity analysis, Maule River Chile, Neveri River Venezuela.

The case studies of two river basins (Maule River, Chile and Neveri River, Venezuela) to which systems analysis had been applied as part of the planning process, were presented. The physical, economical, hydrologic and water use aspects of the basin were described. The data collection and system identification phases of planning were discussed. Objective functions and decision variables were defined, and linear programming models were structured for both basins. Only physical constraints were considered in the initial studies. Other search techniques, and the general use of sensitivity analyses were discussed. Results of the basin studies were presented. It was concluded that linear programming, even with approx data increases the understanding of the planning problem, and that sensitivity analysis and the subdivision of the system for detailed analysis were relatively important in the initial phases of planning. (Gysi-Fla) W68-00869

REGIONAL WATER QUALITY MANAGEMENT · A PILOT STUDY.

Carnegie Inst of Technology, Pittsburgh, Penn. For primary bibliographic entry see Field 05G. For abstract, see . W68-00870

WATER POLLUTION CONTROL USING BY-PASS PIPING,

Univ of California, Los Angeles. For primary bibliographic entry see Field 05G. For abstract, see . W68-00872

WATER QUALITY MANAGEMENT - THE PLANNING OF ECONOMICALLY OPTIMAL POLLUTION CONTROL SYSTEMS,

Univ. of Michigan, Ann Arbor. For primary bibliographic entry see Field 05D. For abstract, see . W68-00873

COMPUTATION OF OPTIMUM REALIZABLE

UNIT HYDROGRAPHS, Massachusetts Institute of Technology, Cambridge; Univ Nacional de Colombia, Medellin For primary bibliographic entry see Field 02A. For abstract, see. W68-00874

THE POLLUTION CONTROL MODELS AND THEIR RESULTS,

Harvard Univ, Cambridge, Mass. For primary bibliographic entry see Field 05D. For abstract, see. W68-00877

COMPUTER MODELS OF WASTE-WATER COLLECTION SYSTEMS, Harvard Univ, Cambridge, Mass.

Melvin E. Holland.

Ph D Thesis, Eng, Harvard Univ, May 1966. 95 p, 17 fig, 7 tab, 13 ref, 3 append.

Descriptors: Computer programs, Design criteria, Constraints, Design standards, *Hydraulic design, Mathematical models, *Computer models, *Wastewater disposal, Pipes, Optimization, Project planning, Sampling, Stochastic processes. Identifiers: Non-linear programming, Sensitivity analysis analysis.

Evaluation Process—Group 6B

A non-linear programming technique was used to find the optimal design solution for a waste-water collection system. The state variables, (system layout, pipe lengths and ground elevations) were assumed to be given. In a first model, the pipe diameters were assumed to be continuously varying decision variables. The cost minimization was qualified by design constraints (max and min velocities, min pipe depths, etc.) and physical constraints (Manning and continuity eqns). The objective function was shown to be convex over the feasible region, indicating that the computer solution was a global minimum. In a second model, random sampling was used to obtain a discrete solution. Only discrete commercially sized pipes were allowed. Two methods of solution were presented, one which started with an approximation to the continuous solution, and another which used an iterative approach. A sensitivity analysis considered the effect of design parameter variation on the continuous solution. Flow charts of the computer programs were appended. (Gysi-Cornell) W68-00878

MATHEMATICAL MODEL FOR WATER POL-LUTION CONTROL STUDIES,

Northeastern Univ. Boston, Mass; New York Univ, New York.

For primary bibliographic entry see Field 05D

For abstract, see W68-00881

6B. Evaluation Process

REPORT OF THE COMMITTEE ON WATER QUALITY CRITERIA.

National Technical Advisory Committee on Water Quality Criteria.

For primary bibliographic entry see Field 05G. For abstract, see.

A GENERAL PLAN FOR THE DEVELOPMENT OF THE RESEARCH TRIANGLE REGION AS AFFECTED BY WASTE DISPOSAL AND WATER RESOURCES.

Research Triangle Regional Planning Commission, Raleigh, North Carolina.

For primary bibliographic entry see Field 05D. For abstract, see .

W68-00846

W68-00656

THE POTOMAC.
U. S. Dept. of the Interior and the Potomac Planning Task Force.

Superintendent of Documents, Washington, D. C. 1967. 103 p, 23 fig, 1 table, 7 maps, 25 illus, 55 photographs. The Potomac Planning Task Force and The American Institute of Architects.

Descriptors: *River basin development, *Urban areas, Resource development, Economics, *Water supply, Water quality, *Inter-agency cooperation, Federal funding, Project planning, *Federal justicitetics risidction.

Identifiers: U. S. Dept. of Interior, Washington, D. C., Potomac River Basin, Potomac Planning Task Force, American Institute of Architects.

The increasing urbanization of the Washington metropolitan area and the existing conditions along the Potomac River led to the establishment of the Potomac Planning Task Force to do a model study of the river which would serve as a model study of river basin development. To achieve its announced murpose of creating a region where the exception purpose of creating a region where the esthetic and economic needs of the population will be met, the study recognizes that the obstacle of fragmented justudy recognizes that the obstacle of fragmented jurisdiction of public agencies in the region must be overcome. To overcome this obstacle, the study recommends the creation of a Federal agency, The Potomac Development Foundation, as the channel through which Federal funds will be used to develop the basin. It further recommends certain principles which should have upon all days lognered. principles which should bear upon all development

decisions: the most critical principle being the planning of the basin as a unit consisting of three divisions: the river, the riverside and the setting. Further recommendations include conducting an ecological inventory of the basin, strategic use of zoning concepts and development of new towns along the river. (Starr-Chicago) W68-00848

LAKE-ORIENTED SUBDIVISIONS IN NORTH CAROLINA: DECISIONS FACTORS AND POL-ICY IMPLICATIONS FOR URBAN GROWTH PATTERNS.

University of North Carolina at Chapel Hill and North Carolina State University at Raleigh.

Raymond J. Burby III. Water Resources Research Institute of the University of North Carolina, Report No. 9, Nov. 1967, 177 p, 6 fig, 18 tab, 53 ref, 4 append.

Descriptors: Watersheds, *Water pollution, *Community development, Political aspects, Flood control, Riparian rights, Recreation facilities, *Public health, *Public rights, Urbanization, Water quality. Identifiers: North Carolina, Environmental planning, Subdivisions, Center for Urban and Resident Studies gional Studies.

The use and implications of environmental innovation in subdivision development is investigated. This study, dealing with developer decisions, proposes that developers will be innovative when they must compensate for bad site characteristics, when the innovative practices make up in revenue for their loss of revenue due to poor sites, and when the developer can save on other costs. Lakeoriented subdivisions are a growing phenomenon in North Carolina, and some serious problems arise from the use of such a resource as a lake by a private sector. These developments can cause threats to public health and safety due to improper design of dams, the utilization of dams designed for agricultural purposes with the resultant threat of flooding as the area becomes urbanized, the problem of water pollution as a result of the almost universal use of septic tanks in this type of development, and the general question of ownership of the lake. The use of community lakes raises certain public policy questions and points to the potential involvement of many public agencies at all levels of government in order to protect the public interest in watershed use, and to maintain water quality. (Starr-Chicago) W68-00849

GUNPOWDER FALLS MARYLAND,

U. S. Department of the Interior, Geological Sur-

Deric O'Bryan, and Russell L. McAvoy. Geological Survey Water-Supply Paper 1815, 1966. 90 p. 45 fig, 5 tab, 31 ref.

Descriptors: *Watersheds, Water resources, Water quality, Recreational facilities, Population growth, *Metropolitan, area, planning and Pi *Metropolitan area planning, *River basin development, Municipal water, Management. Identifiers: Baltimore, Maryland, U. S. Geological Survey, Gunpowder Falls.

Competition between the uses of the basin for water and for recreation and between urban growth and the need for open spaces in the Baltimore metropolitan area will be resolved by compromise, alternative plans and additional development. Construction of more dams in the basin will convert land to water-surface area at a loss of living space. An alternative course would encourage builders in construction of additional impoundments in conjunction with expansion of suburbs and growth of metrotowns. Effects of additional large communities - metrotowns - must be compared with alterna-tive sites. Hydrological evaluations indicate that one alternative site holds to a minimum the conflict between urbanization and water supply. Optimum reservoir conditions for recreation would be those in which water level is not drawn down to expost large expanses of bare shoreline which are unpleas-

ing visually and hinder access to the water. Necessary zoning to protect against pollution of groundwater must not be so restrictive as to limit the growth of a population dense enough to finance the ultimately needed water and waste disposal systems for a community. Planning for highways, which are the avenues of probable growth, should be do take pressure off overtaxed water resources. (Starr-Chicago) W68-00850

WATER SUPPLY AND DISTRIBUTION, MEM-PHIS AND SHELBY COUNTY COMPREHEN-SIVE PLANNING REPORT.

Memphis and Shelby County Planning Commission and the Department of Housing and Urban Development.

Memphis and Shelby Planning Comm. Report No. Tenn. P.45, Feb. 1968, Volume 2 (of 10), 89 p. 17 plates, 28 tables, 2 append. Clark, Dietz and Associates - Allen and Hoshall Joint Venture En-

Descriptors: *Water distribution (Applied), Capital costs, Financial feasibility, Urban areas, *Priorities, *Water supply, *Treatment facilities. Identifiers: Memphis County, Tenn., Shelby County, Tenn., Department of Housing and Urban Development.

Planning relative to a comprehensive water supply and distribution system for Memphis and Shelby County in Tenn. is outlined through 1990. Investigations of existing water facilities in Shelby County reveal that: (1) there are extensive areas in the county without adequate or dependable water supplies; (2) many of the existing treatment facilities are too small to be considered in a comprehensive water system; (3) there are wide variations in the standards of the different utilities. Forecasts of future water requirements indicate that the present ground water aquifer is more than adequate to supply these requirements. Additional water supply and distribution facilities will be needed in order to supply the predicted water requirements. The integrated water system is developed in incremental five-year stages through 1990. Uniform standards are essential for an orderly development of the comprehensive water system. Guidelines standards and the means whereby these standards might be implemented are set forth also. Prioities for providing the recommended improvements are established, with consideration being given to timing and financing of the recommended improvements. Capital improvement programs, including suggested means of financing, are presented for each development stage. (Starr-Chicago) W68-00853

A SYSTEMS ANALYSIS APPROACH TO SANI-TARY ENGINEERING DESIGN PROBLEMS: THE TRICKLING FILTER,
North Carolina State Univ, Raleigh.

William S. Galler.

Proc 14th S Water Resources Pollut Contr Conf, Univ of N C, pp 216-221, Apr 1965. 6 p, 1 fig, 10

Descriptors: Biochemical oxygen demand, Con-Descriptors: Biochemical Oxygen deniand, Constraints, Digital computers, Economic efficiency, Linear programming, *Design, *Systems analysis, Sanitary engineering, *Trickling filters.

Identifiers: Lagrange multipliers.

The problem of cost minimization of a trickling filter was structured. Decision variables in the cost function presented were: (1) filter radius; (2) filter depth; and (3) recilculation volume. Upper limits on the variables to be used in the constraint set were discussed. The mathematical model relating influent and effluent BOD levels was presented. The use of Lagrange multipliers or linear programming (using piece-wise linear approximations) were suggested as methods of solution. (Gysi-Cor-W68-00871

Group 6B—Evaluation Process

AQUEDUCT CAPACITY UNDER AN OPTIMUM BENEFIT POLICY,

Univ of California, Los Angeles. Warren A. Hall.

Amer Soc Civil Eng Proc, Vol 87, No 1R3, pp 1-11, Sept 1961. 11 p, 5 tab, 4 ref.

Descriptors: *Aqueducts, Canal design, Digital computers, *Dynamic programming, Economic efconjuncts, Systamic depending, Economics, *Optimum development plans, Project planning, Intangible benefits, Water allocation (Policy), *Water distribution (Applied), Water supply, Water values.

Identifiers: Recursive relationship.

Using the recursive relationship of dynamic programming the proper allocation of water to various geographic districts along an aqueduct was computed such that the maximum net benefit was obtained. A numerical example using three districts was used but the analysis was general for any single resource being delivered to any number of destinations. Independence of the net benefit functions was required and costs and benefits as functions of quantity of water delivered were assumed given. The recursive relationship stated that the maximum benefit to a certain level stage development was the maximum of the gross benefit to that stage, minus the cost of supplying that stage, plus the net benefit derived from the previous stage. The quantity of water delivered to any stage was the decision variable. (Gysi-Cornell) W68-00880

IN **ECONOMICS** INTERDISCIPLINARY

WATER RESOURCES ANALYSIS,
American Water Resources Association; Rutgers
Univ., New Brunswick, N. J.
William Whipple, Jr.
Proceedings of the Third Annual Water Resources Conference, pp 608-616, Nov 8-10, 1967, 9 p, 13

Descriptors: *Economic feasibility, Economic justification, Economic efficiency, *Risks, *Costbenefit analysis, *Interest rate, *Taxes. Identifiers: Pollution control economics, Interdisciplinary planning, Economics of alternatives.

The economics of interdisciplinary water resources analysis has not been developed adequately. First, there is no agreement as to the unit in which economic value should be measured. Objective functions of economic efficiency and income distribution have been specified, but other alternatives are possible. Economists differ widely as to the rate of discount to be used in project analysis, figures from 2-10% being suggested. The treatment of taxation in comparing projects with private alternatives also requires to be clarified. Economic approaches do not adequately evaluate uncertain outcomes; the principle of mathematic expectations is obviously not adequate. The fields of flood control and of hydroelectric power particularly require an improved economic approach. And in the important pollution control program there is little established economic theory. Specific research as to economic results of water resources improvements are unavoidably interdisciplinary. The organization for interdisciplinary research is difficult since university organization is based primarily on departmental structure. Planners should include a certain number of economists engineers and scientists who have the capacity for interdisciplinary approaches. (Whipple-Rutgers) W68-00882

IMPACT OF WATER RECREATIONAL DEVELOPMENT ON RURAL PROPERTY

VALUES,
Dept. of Agricultural Economics, Penn State Univ,
University Park, Pa.

W. A. Schutjer, and M. C. Hallberg.

American Journal of Agricultural Economics, Vol. 50, No. 3, pp. 572-583, Aug. 1968. 12 p., 4 tab., 12

Descriptors: *Demand elasticity, Land classification, Regression analysis.

Identifiers: Water recreation development, Property values.

The study analyzed the extent to which the peracre value of different types of properties located in the nearby area affected by the park develop-ment, and the way in which the structure of the market for these properties was altered by the park development. The values of properties surrounding the development were compared before and after the development was created to determine its affect on property values. A multiple regression model was used which included twenty independent variables to explain the variation in the per-acre sale price of bona fide property transfers. The transfers were divided into four categories. Elasticities of demand for properties in each category were calculated. Distance from the park, and other property characteristics were closely examined variables. Three aspects of the market were analyzed to determine the impact of the park on the structure of the land market: property size, land use patterns, property characteristics. Public investment in water-based recreational areas significantly influenced the value of rural property. The nature of the impact of the park varies among different properties, and the park has a significant impact on the structure of the land markets surrounding the park. (Grossman-Rutgers) W68-00884

AND EXTERNALITIES EMPIRICISM IN WATER RESOURCES.

Economic Research Service, U S Dept. of Agriculture, Corvallis, Oregon.

Adam A. Sokoloski

Journal of Farm Economics, Vol 49, No 5, pp 1521-1525, December 1967. 5 p, 2 tab, 9 ref.

Descriptors: Sewage effluents, Sewage disposal, *Resource management, Input-output analysis. Identifiers: *Externalities, Yaquina Bay, Newport, Oregon.

An interdisciplinary technique was used to measure empirically external effects in water resources and their relation to group action and management. Pecuniary externalities, or secondary effects, was considered crucial to management policy. In the example used (Yaquina Bay near Newport, Oregon), the quantification of externalities was based on different effluent disposal methods. Examination of alternative disposal methods resulted in the cumulative effect of the existing external relationships. Effect on policy-making issues were examined. Final quantification of externalities was measured by use of a formula that calculated the incremental gain or loss to the area economy resulting from a comparison of changes in costs of disposal and resultant income flows for a given alternative. (Grossman-Rutgers) W 68-00888

ESTHETIC AND RECREATIONAL POTENTIAL SMALL NATURALISTIC STREAMS NEAR

URBAN AREAS, Kentucky Univ., Lexington.

John A. Dearinger. Research Report 13, Kentucky Water Resources Inst. Lexington 1968. 260 p. 34 fig. 38 tab, 82 ref.

Descriptors: *Creeks, *Preservation, *Aesthetics, Watershed management, *Scenery, *Non consumptive use, *Urbanization, *Terrain analysis, Remote sensing, *Social values, Economics, Tourism, *Recreation demand, City planning, Wildlife conservation.

Identifiers: Bluegrass region, Kentucky, *Surburban streams, *Historic sites, *Value judgments, *Natural areas, *Short-term recreational activities.

Research was limited to suburban watersheds under 100 sq. mi. in area. A methodology, based on previous work of the SCS, and the principles of value judgment philosophy and outdoor recreation economics, was developed and applied to two streams (Boone and Jessamine Creeks) near Lexington, Ky. Evaluations were made for camping, fishing, picnicking, trail systems, esthetic enjoy-ment and the establishment of natural, scenic and historic areas. Two other streams and selected sites on Boone and Jessamine Creeks were also evaluated. Extensions of the case studies resulted in procedures for estimating: visitation, future participation demand in an urban area and the proportion of that demand satisfied by a specific site, and the economic benefits that would accrue. Conclusions: (1) Esthetic and recreational values can be identified and used to evaluate a watershed's development potential. (2) Fairly accurate evalua-tions of the watersheds' recreational and esthetic potential were obtained. (3) Many small stream areas have medium to high potential for the kinds of recreational activities considered. (4) Lack of relevant data reduced the validity of visitation predictions. Estimates of participation demand, acreage requirements and annual benefits were somewhat more reliable. (Author) W68-00889

WATER USE IN SOUTH FLORIDA RE-SIDENCES: A SOCIOLOGICAL PRESPECTIVE, Florida Univ., Gainesville, Florida Water Resources Research Center.

Daniel Kubat, Lillian Lei, and George Watkins. Office of Water Resources Research, Project Completion Report A-010-FLA, August 1968, 186 pp, 8 fig, 47 tab, 97 ref, 3 append, 1 disc.

Descriptors: *Water use, *Urban sociology, *Rural sociology, Human population, Social values, Domestic water, *Appliances, Lawns, Water de-mand, *Attitudes, Water requirements, Water conservation, Municipal water, Waste water reuse, Psychological aspects, *Predictions, West Palm Beach, Fla., Homestead, Fla.

Identifiers: Residential water use, Southeastern Florida, Attitudes, Psychological aspects, Social values, Household appliances, Economic levels.

In residential households, relationships between water consumption and certain demographic and social characteristics were ascertainable. The relationships between selected socio-economic variables, household demographic consumption, and household appliance inventories were developed. The household members had measurable degrees of water-use awareness which are related to wateruse and the socio-economic status of each household. The same household members had values regarding water conservation, consumption, and waste which were subjected to an attitudinal scale construction to reveal the strength of these values in specific areas. Some predictions regarding future water needs in the sampled residential areas were made. (Watkins-Fla) W68-00913

FUTURE DEVELOPMENT OF THE GROUND-WATER RESOURCE IN THE LOWER GREAT MIAMI RIVER VALLEY, OHIO--PROBLEMS AND ALTERNATIVE SOLUTIONS,

U S Geological Survey For primary bibliographic entry see Field 04B. For abstract, see .

W68-00961

ALTERNATIVES IN WATER MANAGEMENT.

Committee on Water Division of Earth Sciences, National Academy of Sciences, National Research Council, Wash., D. C.

National Academy of Sciences - National research Council Publication No. 1408, 52 p, 3 ref.

Descriptors: *Multiple-purpose, Decision making, Non-structural alternatives, Multiple-purpose projects, Research and development, Optimum development plans, Social values.

Evaluation Process—Group 6B

A consideration of the intangible values of water management should be undertaken now that science and technology have enlarged the range of possible alternatives. However, there is still a lack of facility in dealing with the results of the scientific investigations which limits the possibility of formulating alternative ways of achieving multiple aims. The study makes three major recommendations: (1) all organizations, public or private, engaged in planning the water use should be reorganized adequately enough to permit increased attention to alternative approaches and courses of action, to give an appraisal of social costs and benefits, and to the efficient use of existing research as a means of reaching solutions; (2) practicable alternatives should be presented for consideration and evaluation to concerned citizens, groups and elected officials; and (3) the scientific community should expand their research efforts to an investigation of all the problems related to water - physical, biological and social. A national economic development policy is recommended which would trade off primary among persons of different incomes and among regions. (Starr-Chicago) W68-00980 benefits in order to have a desirable distribution

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WATER RESOURCES PLANNING STUDY OF

THE FARMINGTON VALLEY,
Travelers Research Center for Water Resources
Comm., State of Conn., Hartford.
Paul Bock, Edwin E. Pyatt, and John A. DeFilippi.
The Travelers Research Center, Inc. Feb. 1965, 373 p, 141 illus, 46 tab, 4 append.

Descriptors: Flexibility, Future planning (Projected), Methodology, Multiple-purpose, Multiple-aidms, Non-structural alternatives, Optimum development plans, Urbanization, Cost-benefit analysis

Identifiers: Connecticut, Massachusetts, Hartford, Conn., Holyoke, Mass., Farmington Watershed.

This study of the Farmington Valley which lies in both Connecticut and Massachusetts, encom-passing the Hartford-New Britain axis, has been based on the population projections of the 'linear plan' of the Capitol Region Planning Agency which predicts a trebling of the population by 2015. The study is founded on a multi-discipline quantitative methodolgy but conditioned by qualitative evaluations and jedgements made by many agencies and layment of the area. Study procedures consist of: (1) water resources inventory; (2) analyses of supply and demands of major water uses; and (3) multi-purpose analyses to meet optimally the competing regional demands of water resources - both benefit-cost and least-cost analyses. The major water purposes of the region include water supplies of all types, flood control, riparian water recreation, pollution abatement and aesthetics. Structural additions to the system would be a triple-purpose Colebrook River project which would provide flood protection, increase water supply safe yields and in-reservoir fishing opportunities and augment low-stream flows. Recommendations include the dual-use of a water supply reservoir to include recreational purposes, staged purchasing of ripari-an waters and strengthened local programs for flood protection based on non-structural measures. (Starr-Chicago) W68-00981

A FRAMEWORK FOR THE MULTIPLE-USE OF MUNICIPAL WATER SUPPLY AREAS, Cornell University, Ithaca, Water Resources

Van Nierop, and Emmanuel Theodorus. The Water Resources Center, Cornell University, July 1966, 153 p, 108 ref, 1 append.

Descriptors: *Water supply, *Reservoirs, Recreation demand, Multiple-purpose projects, Economic feasibility, *Public health, Water purification, *Impaired water quality, Enteric bacteria. Identifiers: New York State.

The feasibility of adapting an originally designed single-purpose project such as a water supply system into a multiple-purpose project is investigated in this study. The problems associated with opening up a municipal reservoir for recreational purposes is analyzed with respect to the is sues of public health, financing of a recreational program and the practicability of multiple-use management practices on reservoir lands owned by a municipality. A methodology was developed which included mailing questionnaires to municipalities in New York State operating water water supply reservoirs and conducting a review and critical analysis of literature relevant to the subject of multiple use. The major findings of the study were that the recreational operation of municipal reservoir areas constitutes a potential hazard to public health. This hazard could be minimized by a maximum degree of treatment and control, but recreational activities which involve bodily contact with water should be prohibited under all circumstances. The study recommends that, in view of the complex problems associated with allowing public access to reservoir areas, a municipality should not consider changing its exist-ing policy unless there is a real demand for such a change. (Starr-Chicago) W68-00984

PLAN FOR DEVELOPMENT OF THE LAND AND WATER RESOURCES OF THE SOUTHEAST RIVER BASINS SOUTHEAST RIVER CHATTAHOOCHEE APALACHICOLA FLINT BASINS - APPEND. 7.

United States Study Commission, Southeast River

United States Study Commission, Appendix 7, 207 p, 111 illus, 56 tab.

Descriptors: *River Basin Development, River Basin Commissions, *Water resources development, Water supply, Inter-basin uses, Multiple-purpose projects, Flood control, Hydroelectric power,

Recreation, Alternative costs. Identifiers: Southeast U.S., Georgia, Florida, Alabama, Apalachicola, Chattahoochee River, Flint River.

There were four basic steps taken in the procedure for formulating a comprehensive plan for the basin which contains the three metropolitan areas of Atlanta, Columbus and Albany: (1) An inventory was made of basic resources and related development within the basin; (2) Needs for goods and services were projected to year 2000; (3) Alternative ways to meet needs for each purpose were studied; and (4) Projects that would best serve all purposes and meet projected requirements for resource conservation, utilization and development were selected. Also, the nature and the effect of plans in other basins were also considered in order to permit optimum interbasin uses. The plan was formulated by a specific initial proposal as the nucleus around a specific initial proposal as the nucleus around which planning took place. Single purpose planning for each purpose was carried to the point of establishing needs and most likely ways of meeting the needs. Information developed in single-purpose planning and the special problems of the area were the initial bases for development of a multiple-purpose planning and the special problems of the purpose the initial bases for development of a multiple-purpose planning and the special problems of the problems pose plan for the basin. Consideration was given to complementary land and water uses. It was found that water resource development plans could serve the purposes of flood control, hydroelectric power, water supply, fishing and recreation. (Starr-Chicago) Chicago) W68-00985

ALTERNATIVE LONG RANGE WATER USE PLANS FOR THE TRI-COUNTY REGION, MICHIGAN.

Tri-County Regional Planning Commission,

Tri-County Region Lansing, Michigan.

Tri-County Regional Planning Comm., Michigan Tech. Report, 1963, 187 p, 61 tab, 27 fig, 4 ref, 4 append.

Descriptors: *Urbanization, Land-use, Watertreatment, Water supply, Population projections. Lansing, Michigan, Tri-County. Identifiers: Michigan.

Economic and resource data pertinent to the three-county region in Michigan has been assembled in this report. The data is interpreted in an attempt to translate the future water requirements of this region into broad alternative plans. The methodology involved three major steps: (1) Projections were made of economic growth to the year 2000. The projection which forecast the largest population and greatest industrial growth and the greatest water demand was selected as the basis for estimating water requirements for the year 2000; (2) Detailed projections were made for residential, industrial, commercial, agricultural and public purposes and projected on a per capita basis for re-sidential and public purposes; and, (3) These pro-jections were translated into specific alternative water plans. Recognition was made of the fact that water plans. Recognition was made of the fact that plans for water and sewage treatment could be different, depending upon the physical pattern of growth; whether physical growth took the form of planned sprawl, satellite communities or along corridors of this ten-township area. There are 'first estimate' land use maps for each of the alternative patterns of physical growth. (Starr-Chicago) W 68-00987

WATER RESOURCES AS AN ELEMENT OF URBAN PLANNING,

Northeastern Ill. Planning Comm., Chicago Matthew L. Rockwell.

Journal of the Urban Planning and Development Division, ASCE, Vol. 94, No. UP1, Proc. Paper 6056, August, 1968, pp. 1-9.

Descriptors: *Water resources development, *Land-use, *Economics, *Inter-agency cooperation, Urban areas. Identifiers: N.E. Illinois, Chicago, Illinois, Northeastern Illinois Planning Commission.

In northeastern Illinois, the evolving water situation is characterized by the availability of several sources, a high intensity of use and reuse, increasingly complex technical, legal and administrative problems and a large number of management alternatives. The paper suggests that a metropolitan comprehensive planning agency provides a formalized base from which a selection of management alternatives may be made. The paper makes a distinction between water resources and the water resource. I his distinction is made to emphasize the interconnectedness of this singular resource. Some of the recommendations made include: (1) Integrating water resource objectives with land use plans; (2) Identifying the practical range of management measures; (3) Maintaining maximum flexibility in the decision-making process; (4) Assuring that projects are economically sound; and, (5) Coordinating efforts with state and interstate. resource. This distinction is made to emphasize the (5) Coordinating efforts with state and interstate efforts. (Starr-Chicago) W68-00989

THE ECONOMICS OF MASSIVE INTER-BASIN WATER TRANSFERS,

Oregon State Univ., Corvallis, Dept. of Agricultural Economics.

Emery N. Castle.

Paper presented to Seminar, Washington State University, Pullman, Washington, April 15, 1968 15 p, 5 ref.

Descriptors: *Feasibility, Institutional constraints, *Inter-basin transfers, Marginal productivity, Water values Identifiers: Economics, *Water transfer.

The necessary economic conditions for water transfer on a nonmassive scale were given. Three variables were delineated: (1) the worth of water in its least valuable use in the deficit area; (2) the worth of water in its least valuable use in the sur-plus area; and (3) the cost of transfer. Water should be transferred from a lower to a higher

Field 06-WATER RESOURCES PLANNING

Group 6B—Evaluation Process

valued use within the deficit area rather than importing water from the surplus area. The value productivity of water was classified into (1) the direct value of water to the water user, and (2) the benefit that would accrue to those producers and consumers that were affected by activity of the water user. The future value of water and the indirect effects must be considered in the economic analysis of water. If the following assumptions were made: (1) current conditions are relevant to a decision and (2) the transfer is not so massive as to completely change the character of the importing or exporting region, the following would have been concluded: interregional or interbasin water transfer in the West is not justified on economic grounds. When considering massive water transfer it was not clear whether the effects would invalidate economic analysis. (Grossman-Rutgers) W68-00997

6C. Cost Allocation, Cost Sharing, Pricing/Repayment

ARE WATER RIGHTS MARKETABLE IN WISCONSIN, Law School of the U of Wisconsin, Madison.

Michael St Peter. Wis L Rev, Vol 1966, No 3, pp 942-950, Summer 1966. 9 p, 29 ref.

Descriptors: *Wisconsin, *Riparian rights, Legislation, Judicial decisions, Water power, *Riparian

land, Contracts, Federal government, Relative rights, Water resources development, Political aspects, Dams, Water law, Water policy, Severance

One method of allocating scarce water resources is through the economic or market process. Under the riparian system this is often thought to be impossible as riparian rights are inherent in the land, and not severable from it. This article suggests that under the riparian doctrine water rights can be made marketable by both private contract and legislative grant. The first series of cases discussed involved the granting of the riparian right to water power by contract, without granting the adjoining riparian land. The court gave effect to the private contract, rather than deciding the case on ordinary riparian principles. Where the grantor conveyed more power than was available from the dam, the court held that the power would be allocated on the cronological basis of the contracts. The courts have also given effect to the reservation in a deed by a canal company to the United States, of 'the water powers created by the dams, and the use of the surplus water not required for navigation...', thus approving an implied legislative grant of riparian rights to the canal company separate from the riparian land. (Kirkconnell-Fla) W68-00760

TRANSFER RESTRICTIONS AND MISALLO-CATIONS OF IRRIGATION WATER,

Utah St. Univ., Logan; Iowa St. Univ., Ames.
B. Delworth Gardner, and Herbert H. Fullerton.
American Journal of Agricultural Economics, Vol. 50, No. 3, pp 556-571, Aug 1968. 16 p, 3 fig, 3 tab.

Descriptors: *Covariance analysis, *Regression analysis, Productivity marginal value product, *Water transfer, Water rates.

Identifiers: *Irrigation water, *Economic efficien-

The criteria for economic efficiency were explained. If transfer regulations restricted factors, the values of marginal products would be below optimal levels. It was hypothesized that by allowing inter-company transfers of irrigation water there would be a significant increase in the marginal value product of water. Multiple regression analysis was utilized to determine which of the variables with a prior importance had significant influence on the rental price of water. The area studied was in Utah where four companies freely exchanged water after a long period during which only intracompany transfers were permitted. Covariance analysis was used to determine the impact of a change in transfer rules on water rentals after the effect by other significant variables had been removed. The transfer policy in effect and the water supply were the explanatory variables which have accounted for most of the variation in the rental price of water from 1934 to 1964 in the area studied. Tables giving time series data, and the statistical parameters were included. Also, three price-quantity relationships were diagramed. Grossman-Rutgers) W68-00992

ECONOMIC PRINCIPLES OF RESOURCE AL-LOCATION AND THEIR APPLICATION TO WATER PRICING, Montana St. Univ., Bozeman, Dept. of Economics

and Rural Sociology. Chennat Gopalakrishnan.

Water Resources Bulletin, Vol. 3, No. 2, pp. G-9, June 1967. 4 p, 2 fig, 3 ref.

Descriptors: *Concept of proportionality, *Equimarginal principle, Pricing. Identifiers: Economics, Water allocation (Resource)

The theoretical basis of water resource allocation was explained in terms of two concepts: (1) the concept of proportionality, and (2) the equi-marginal principle. In practice the equi-marginal principle does not apply as noticed by the price differentials and among different uses of water. In a purely competitive set up, the tendency would be for the price of water to be the same for different uses. However, due to institutional factors, the free transfer of water from one use to another does not occur. Two factors also limit the application of theoretical principles to water resource allocation. First, water can be put to a number of uses, which are noncompetitive in nature; second, very large investment aggretates are involved in the construction of multi-purpose projects. This is unterrable with the assumption that resources can be divided into any number of smaller units. (Grossman-Rutgers) W68-00993

COST OF PUMPING IRRIGATION WATER IN CENTRAL ARIZONA,

Arizona Univ. Tucson. Aaron G. Nelson, and Charles D. Busch. Tech Bull 182, Ariz Agr Exp Sta, Univ of Arizona, April 1967. 44 p, 24 tab, 2 fig.

Descriptors: Cost-benefit ratio, *Cost comparisons, Irrigation operation and maintenance, Arizona, *Wells, *Pumping, Acreage, Irrigation districts, Irrigation efficiency, *Farm power production, Electric power costs, Economic feasibility, Pumps, Feasibility studies, Efficiencies, Capital costs, *Cost analysis, Surveys. Identifiers: *Gas power.

The cost of pumping water for irrigation in Maricopa and Pinal counties of central Arizona was determined for electric and gas wells on an acre-foot and acre foot per foot of lift basis. Costs and related data for farm survey electric and gas wells were substantiated by the accurate data of irrigation district wells. The quantity of water pumped per electric well averaged 870 acre ft and 1084 acre ft for gas wells. Irrigation districts averaged 1,558 acre feet. Overall efficiency for the pump and power unit was 52% for the electric wells, 13% for the gas wells and 59% for the irrigation districts. Comparisons with maximum efficiency showed both electric and gas operated at the same level of efficiency. Based on rates of 9 mills per KWH and 40 cents per 1,000 ft for gas it was found costs per acre foot of lift varied from 2.036 to 2.786 cents for electricity and 0.929 to 1.152 cents for gas. Efficiency of the purpose o ciency of the pump and power unit had a significant

influence on pumping costs. Raising efficiency of electric wells from 40 to 65% reduced power costs 40%. (Affleck-Ariz) W68-01003

6D. Water Demand

ECONOMIC CONTROL OF GROUNDWATER

RESERVES, Missouri Univ., Department of Agricultural Economics. Oscar R. Burt.

Amer J of Agr Econ, Vol 48, No 3, Part 1, pp 632-647, August 1966. 16 p, 1 fig.

Descriptors: *Groundwater basins, *Economics, *Water policy, Water allocation (Policy), Economic impact, Mathematical models, Recharge, Hydrologic budget, *Equations, Numerical analysis, Probability, Storage capacity, Social aspects, Cost-benefit ratio.

Identifiers: Decision model, Bellman's principle, *Economic aspects.

The objectives of the article are to show that a conditional expected-present-value-of-net-benefits function and its optimal policy are necessary for an economical solution to the problems of monality in groundwater basins, and secondly, to develop a sequential decision model that can be used to derive empirical estimates of these functions. The commonality problem is that users of groundwater resource have no claim to the common pool that may exist in the future except that they can use as much as they please at any point in time until total supply is exhausted. Although the classical approach is relatively simple in principle, it is a complex problem to determine marginal-social-cost function for groundwater. Expected-present-value function for net benefits under a socially optimal policy provides the marginal-social-cost function required to solve the problem of commonality. Bellman's principle of optimality provides the basis for formulating a recursive optimization equation. Once the sequential decision process for groundwater allocation has been optimized, groundwater stocks through periods of time follow a Markov process in its discrete-variable approximation. There are equations and assumptions for determining economic control of groundwater reserves. (Blecker-Ariz) W68-00704

INTEGRATED OPERATION OF MULTIPUR-POSE RESERVOIRS FOR IRRIGATION, FLOOD CONTROL, AND OTHER PURPOSES ON BUREAU OF RECLAMATION PROJECTS, Bureau of Reclamation, Washington, D.C. Gilbert G. Stamm.

Int Comm on Irrig and Drainage, 6th Congress, Vol 5, Question 22, pp 45-70, 1966. 26 p, 5 fig.

Descriptors: *Multiple-purpose reservoirs, Federal Reclamation Law, Reclamation states, Arid climates, Semiarid climates, Water rightts, *Reservoir operation, Interstate compacts, Flood control, Recreation demand, Hydroelectric power, Central Valley Project, Water storage, *Water resources development, Irrigation programs, Limited factors. Identifiers: Minidoka-Palisades Project, Irrigation agriculture.

Systems and patterns of water management on Federal Reclamation projects in the arid and semi-arid western half of the United States are the product of an historical evolution spanning a product of an historical evolution spanning a period of more than sixty years. The complexities, problems, and constraints imposed by the physical settings as well as the existing legal, institutional, political and other man-made requirements and limitations are used in tracing the efforts to achieve optimum water resource utilization through the integrated operation of multipurpose Reclamation reservoirs. The Minidoka-Palisades Project in Idaho and Wyoming served as an example of an integrated reservoir system operating under constraints imposed by a complex system of water

rights and by provisions of an interstate compact. The Central Valley Project in California affords an insight into the operational facets and problems of this enormously complex integrated system of reservoirs and other facilities involving water storage, trans-basin diversion, exchange transfers and long-distance conveyance to serve a wide variety of beneficial purposes. (Blecker-Ariz) W68-00734

APPROPRIATION WATER LAW ELEMENTS IN RIPARIAN DOCTRINE STATES, U of Buffalo, Buffalo, N. Y.

J. H. Beuscher. Buffalo L Rev, Vol 10, No 2, pp 448-458, Winter 1961.11 p, 1 tab, 48 ref.

Descriptors: *Appropriation, *Riparian rights, Industries, Natural flow doctrine, Reasonable use, Prescriptive right, Usufructuary right, Water law, Legal aspects, Zoning, Public rights, Cities, Utilities, *Wisconsin, *Minnesota, Relative rights, Prior appropriation.

The elements of the law of appropriation found in riparian states are discussed. Overgeneralization into a strict dichotomy obscures differences between riparian states, and magnifies differences between riparian and appropriation states. Modern demand for change could be expedited if these similarities were recognized. The traditional elements of the two systems are contrasted in a table. Story and Kent used a two level analysis of the riparian doctrine: the idealistic natural flow doctrine, qualified by the practical reasonable use doctrine. In application, the reasonable use doctrine is emphasized. Specific examples of erosion of the riparian doctrine are: (1) the vested prescriptive right, which may not be divested by subsequent riparians; (2) a riparian's right to consume as much water as necessary for his domestic use; (3) first dam builder is protected from later dam builders. Dam builders can withhold the natural flow; (4) tendency to treat municipal users differently than private users; (5) dissimilar treatment of industrial. mining and irrigation users; (6) zoning ordinances may be used to disrupt riparians' equality. The expanding test of navigability also limits riparian rights by recognizing public rights. (Williams-Fla) W68-00748

LA NASA V SEWERAGE AND WATER BD (WATER SUPPLY CONTRACT). 184 So 2d 622-625 (Ct App La 1966)

Descriptors: *Louisiana, *Water supply, *Water users, Judicial decisions, Administrative agencies, Remedies, Contracts, Cities, Local Government, Water distribution (Applied), Domestic water, Water works. Identifiers: *Injunction.

This was an action by the owner of rented property against a city sewerage and water board for a mandatory injunction to require the board to restore water service to the property. Plaintiff owned commercial property which he leased to one Taylor. Taylor defaulted on his water bill and vacated the premises. Plaintiff then rented the property to the present tenant. The board refused to restore water service to the property until Taylor's delinquent bill was paid. There was no contractual relationship between plaintiff and defendant to supply water to the property during Taylor's occupancy. The court held that the board did not possess the legal right to refuse water service to the owner or present tenant until either of them paid off former tenant's delinquent bill. The board could have protected itself by requiring a deposit before extending service. The court refused to create a judicial lien on property for payment of water bills where no contract existed between the board and the owner of the property. (Kirkconnell-Fla) W68-00766

THE WATER RESOURCE IN NORTHEASTERN ILLINOIS: PLANNING ITS USE,

Northeastern Illinois Planning Commission

Chicago, Illinois.

John R. Sheaffer, and Arthur J. Zeizel.

N.E. Illinois Planning Commission Technical Report No. 4, June 1966, 182 p, 55 fig, 40 tab, 96 ref.

Descriptors: Inter-basin transfers, Land use, Nonstructural alternatives, Water demand, Conjunctive use, Water quality control, Regional analysis, *Urbanization, Recreation demand, Future planning (Projected), Water resources development, Legislation.

Identifiers: N. E. Illinois, Chicago metropolitan area, Northeastern Illinois Planning Commission.

The study stresses the advantages of closely coordinating water resource management with alternative patterns of urban development. Surface water is pointed to as one of the chief natural attributes of the region that should be featured in land use planning on both metropolitan and local scales. The study assesses the potential of the various water sources available, analyzes the manner in which they are used, presents numerous alternative water management measures, and balances supply against future demands under various types of management. Legislation related to water management is analyzed and recommendations are advanced for legal areas where changes are deemed desirable. Problems focused upon in this report include pollution of surface and ground water, falling water levels in wells, damaging floods alternating with periods of inadequate stream flow, the grow ing shortage of water-oriented recreational facilities, and the general overall laxity in applying known management techniques. The general categories of management measures include: (1) storage of surface water and interbasin transfer; (2) management of the withdrawal and replenishment of ground water; (3) possibilities for conjunctive use of surface and ground water; (4) water quality management and, (5) management of water use. (Starr-Chicago) W68-00843

PRESENT AND FUTURE WATER USE AND ITS EFFECT ON PLANNING IN MARICOPA COUN-TY, ARIZONA,

Maricopa County, Arizona County Board of Supervisors and Maricopa County Planning and Zoning Commission and Department.

Heinrich J. Thiele. Maricopa County, Arizona Planning and Zoning Commission, September 1965, 60 p, 1 map, 12 plates, 28 tables, 52 references.

Descriptors: *Water resource development, Mathematical models, *Land use, Water supply, *Diversion, *Water management, Metropolitan growth, *Zoning.

Identifiers: Maricopa County, Arizona, Phoenix, Arizona, Mesa, Arizona, Tempe, Arizona, Scottsdale, Arizona,

This report on the Phoenix Metropolitan Area contains an analysis of the conditions, trends, needs and problems of water availability which influence the location, type and extent of land uses that can be supported. The study is divided into three parts: (1) Water Use Study; (2) Water Resources Study, 1963; and (3) Water Utilization Potential Study to 1980, with trends projected beyond the year 2000. The study suggests that the modern approach to water planning is to prepare alternate models of growth concepts; this study, however, uses a single approach only. This approach does not take into account the augmenting of available water from outside sources, but points to the importance of ultimately doing so. The study theorizes that 1.5 million of the 3.2 million persons that could be supplied with domestic water from present resources could live in a second metropolitan subcenter in the Mesa-Tempe-Scottsdale area. The study recommends additional studies to coordinate and interpret economic data assembled; to coordinate water resources management with the physical

planning process; and to evaluate and interpret al-ternate land-use water plans. Zoning patterns for the area could then be developed that could permit a population density that could be supported by adequate water resources at all times. (Starr-Chicago) W 68-00845

METHODOLOGY FOR APPROACHING WATER QUALITY PROBLEMS, Resources for the Future, Inc.

Blair T. Bower.

Mimeographed paper presented at the Western Agricultural Economic Research Council Commit-tee on the Economics of Water Resources Development, Las Vegas, Nevada, 7-8 December 1966, 30 p, 9 fig, 7 tab, 28 ref.

Descriptors: Water quality, Water quantity, Economics, Regional economics, Methodology, Water quality management, Costs, Benefits, Loss functions, Systems analysis, Input-output analysis, Simulation, Trade-off functions, Technological change, Water treatment economics, Information

Identifiers: Physical relationships, Technology, Theory of the firm, Industrial use, Agricultural use

Necessary factors for an economic approach to water quality analysis are outlined. Economic methodologies must determine direct benefits from improved water quality, direct damages from deficient water quality, direct costs to obtain different levels of water quality, and direct impacts of water quality on a regional economy. Essential inputs are: physical, economic and technological interrelationships. The following methodological needs have been identified: (1) relationships between water quality and various water uses; (2) development of loss functions relating to water quality deficiencies; (3) delineation of trade-offs between water quality improvement and other outputs from water resource systems; (4) cost specifications of information systems' necessary for water quality management, and (5) further development of regional models to trace impacts of water quality throughout a regional economy. (Davis-Chicago) W 68-00851

WATER QUALITY A DEVELOPMENT, Resources for the Future, Inc. AND **ECONOMIC**

Blair T. Bower

Mimeographed speech presented at Seventh Industrial and Economic Development Conference, Pullman, Washington, 3 October 1966, 21 p, 1 fig, 1 tab, 18 ref.

Descriptors: Water quality, Water quantity, Economic development, Water resource economics, Regional economics, Water resources agency, Theory of the firm, Industrial develop-ment, Stochastic processes, Location theory, Economic decision-making, Water treatment, Pollution control, Input-output analysis, Trade-off analysis, Institutions.

Identifiers: Water resource management, Self-contained water systems, Industrial waste problems, Industrial use, Technological change.

Economic decision-making regarding the role of water quality in industrial development is analyzed on a regional level and at the level of the firm. on a regional level and at the level of the firm. Water is a negligible factor in the interregional locational decisions for the firm, and is but one factor in the development decisions within a region. On the regional level, the role of water quality is again only one factor contributing to regional economic development. The objective of regional decisions is minimizing basinwide costs of water quality, as the objective at the level of the firm is minimizing total production costs. The basic problem of water quality as a hindrance to development is institutional. The solution is a competent water resources agency with over-all responsibility for all outputs of water resources systems, including water quality management. (Davis-Chicago) W68-00852

Group 6D—Water Demand

GROUND-WATER MANAGEMENT FOR THE NATION'S FUTURE - OPTIMUM CONJUNCTIVE OPERATION OF GROUND-WATER

California Dept of Water Resources. For primary bibliographic entry see Field 04B. For abstract, see W68-00875

THE ECONOMICS OF WATER UTILIZATION IN THE BEET SUGAR INDUSTRY,
For primary bibliographic entry see Field 05C.

For abstract, see. W68-00883

WITHIN RECREATION: CONFLICTS EMERGING PROBLEM IN THE ALLOCATION OF WATER AND INVESTMENT FUNDS,

Dept. of Agricultural Economics, Missouri Univ, Columbia, Mo.

John A. Kuehn, and Durward Brewer Land Economics, Vol 43, No 4, pp 456-461, Nov 1967. 7 p, 1 fig, 10 ref.

Descriptors: Economic efficiency, Recreation demand, Optimization, *Cost-benefit analysis, Externalities, Multiple-purpose reservoirs, Lagrangian multiplier functions, National parks, Streams. Identifiers: *Recreation facilities, Investment, Water allocation (Policy).

The use of federal reservoirs for recreation has increased at a rate of 10 percent annually. 44 percent of the population preferred water-oriented recreational activities over others. Local economies near recreational areas have benefitted. The development of recreational reservoirs have sacrificed stream resources without evaluating the resulting negative benefits. The preservation of streams is also important. National parks have also been threatened by reservoir construction. Recreation specialists and resource planners should efficiently allocate water, public funds, and facilities between reservoir projects and free-flowing stream preservation and improvement. Efficiency norms should be adhered to in order to maximize the national welfare from recreation. The planning goal should be balanced recreational river basins. The basin is an appropriate planning unit. The interpretation of data should be comprehensive. The benefit-cost analysis may be used in conjunction with three necessary steps. Planning and decision roles should be separated from actual construction and opera-tion. (Grossman-Rutgers) W68-00885

EMPIRICAL ANALYSIS OF THE DEMAND FOR WATER BY ISRAELI AGRICULTURE. Hebrew Univ, Jeruseleum, Israel.

Dan Yaron.

Journal of Farm Economics, Vol 49, No 2, pp 461-473, May 1967. 13 p, 2 fig 1 tab, 20 ref.

Descriptors: *Empirical analysis of demand, Production function, Irrigation norms, Economic efficiency, *Linear programming, Programming al-

gorithms. Identifiers: *Water demand, Israeli agriculture.

Empirical analysis of the demand for water was based on the thesis that irrigation water was a factor of production. Farm-level and country-wide production functions were used and it was assumed that the marginal yield of a crop was a function only of the quantity of water used. The demand for water was directly derivable from the production function. The particular irrigation techniques apfunction. The particular irrigation techniques applied on the farms and the degree of mobility of farm labor were the most important factors to affect the demand for water. The shape of the demand function for water was dependent on the sociopolitical economic mix. The degree of efficiency in water allocation dictated the rules of aggregation of the demands of individual farms into the demands of larger groups. (Grossman-Rutgers) W68-00886

EFFECTS OF NON-PRICE VARIABLES UPON PARTICIPATION IN WATER-ORIENTED RECREATION.

Dept. of Agricultural Economics, Missouri Univ, Columbia, Mo.

Glenn A. Gillespie, and Durward Brewer. American Journal of Agricultural Economics, Vol 50, No 1, pp 82-90, Feb 1968. 8 p, 3 fig, 5 tab, 6

Descriptors: Economics, Water recreation, *Regression analysis, Socio-economic factors. Identifiers: *Water demand, Recreation demand, Elasticity of demand.

The demand for water-oriented outdoor recreation was measured using factors that affected the quantities consumed. Price was held constant by sam-1,000 households in the St. Louis metropolitan area. The following recreation activities were included: swimming, water skiing, ice skating, camping, picnicking, boating, boat fishing, hunting, sight-seeing, nature walks, golfing, and other. The standard multiple regression model was used. The dependent variable was recreation day and the independent variables were both qualitative and quantitative. Some independent variables were zero-one dummy variables. Income and age were the primary variables and were significantly interrelated. The income elasticity of demand for recreation was calculated. Income had a greater influence on demand for recreation on older people than on younger people. Age elasticities and education elasticities were also calculated. This model may be used to predict the number of recreational days demanded by a family with specific socio economic characteristics. Mathematical models, tables, and references were included. (Grossman-Rutgers) W68-00887

ECONOMIC BASIS FOR WATER RESOURCES ANALYSIS,

Rutgers Univ., New Brunswick, N J. William Whipple, Jr.

Water Resources Research Institute, Rutgers, the State University, 116 pp, 8 fig., 6 tab, 86 ref, 1 append.

Descriptors: *Uncertainty, Risks, Economic efficiency, *Economics, *Economic benefits, Cost benefit analysis, Decision making, Economic iustification, *Interest, *Economic resources, justification, *Interest, *Economic resources, Flood plain insurance, *Flood plain zoning, *Taxes, *Hydro-electric power, *Flood control, *Water pollution control.

Identifiers: Utility, Objective function, Economics of flood control, Economics of taxed alternatives, Utility function of uncertainty.

This work purports to provide improved economic principles and methodology for water resources planning. A basic utility objective function is proposed, which can be quantified except for special cases where income redistribution is relevant. A stochastic approach is developed to provide a quantitative utility function of uncertainty, based upon social valuation of risk inferred from in-surance and other fields. The analysis of risk and theory of opportunity costs is used to derive an aptheory of opportunity costs is used to derive an ap-proach to government discount rate, and to con-sideration of taxation in comparisons of projects with alternatives. In the field of hydroelectric power, it is shown that these principles will approximately halve traditional benefit-cost ratios. A special study of flood control provides a new approach to the optimal degree of protection, and to flood plain management, through consideration of project-induced investment in flood hazard areas. sential principles are given for an economic evaluation of the benefits of pollution control and a method for optimizing planning including water quality objectives. (Author) W68-00936

WATER FOR OKLAHOMA, U S Geological Survey. T. B. Dover, A. R. Leonard, and L. L. Laine. U S Geol Surv Water-Supply Pap 1890, 1968. 107 p, 18 fig, 12 ref.

Descriptors: *Water resources, *Water supply, *Groundwater, *Surface waters, *Oklahoma, Hydrology, Water management (Applied), Water resources development, Reservoir storage, Water conveyance, Water demand, Irrigation, Municipal water, Hydrologic budget. Identifiers: *Oklahoma water-resource survey.

The water resources of Oklahoma are described in a report compiled from various published and unpublished sources. Basic information about general geology and hydrology are included to increase the comprehensibility of the report to the non-specialist. About 1% of the water that enters Oklahoma as precipitation or streamflow is used by man. The rest evaporates or flows out. Precipitation averages 33 in. per yr of which evaporation uses over 85%, leaving about 17 bgd for potentially useful infiltration and runoff. Withdrawal in 1965 averaged 1.25 bgd, 2/3 of which was surface water. The western part of the state is the principal groundwater consumer and the extreme part. groundwater consumer, and the eastern part uses the most surface water. Consumption may double in the next twenty years. The average amount of available water is ample, but droughts are severe and frequent, so managed storage is necessary. Both surface and subsurface storage are being used, and the potential for increase of both is excel-lent. The quality of most water in the State is excellent but some groundwaters and surface waters are too salty for any use. The water resources of the High Plains, Western Oklahoma, the Central and Eastern Plains, the Ozark Plateaus, Southeastern Oklahoma, and the major cities of Oklahoma, are discussed in more detail. (Knapp-USGS) W68-00963

FACTORS AFFECTING CONSUMPTION OF URBAN HOUSEHOLD WATER IN NORTHERN UTAH,

Utah St. Univ., Logan, Agricultural Experiment Station.

B. Delworth Gardner, and Seth H. Schick

Bulletin 449, Nov 1964, Agricultural Experiment Station, Utah State University, Logan 21 p, 9 fig, 3

Descriptors: *Regression analysis, *Demand, Income, Prices, Rain, Air temperature, Acreage, Property values, Plumbing, Price elasticity, *Sampling. Identifiers: *Water utilization, Economics.

The consumption of water by average households among various communities in northern Utah was explained. The variables used to explain household consumption were price, income, value of homes, lot area, percent of homes with complete plumbing, precipitation, and temperature. Price and lot size were found to be the most significant variables. The demand schedule and demand curves for both linear and logarithmic functions were found. Numerous tables of data and statistical results, two graphs, and an appendix were included. (Grossman-Rutgers) W68-00990

THE IMPACT OF PRICE ON RESIDENTIAL WATER DEMAND AND ITS RELATION TO SYSTEM DESIGN AND PRICE STRUCTURE, Resources for the Future Inc, Wash., D. C., Johns Hopkins Univ., Depart. of Environmental En-

gineering Science. Charles W. Howe, and F. P. Linaweaver. Water Resources Research, Vol 3, No 1, pp 13-32, First Quarter 1967. 20 p, 5 tab, 23 ref.

Descriptors: *Elasticity of demand, Systems analysis, *Pricing.
Identifiers: Economics, *Water demand, *Water

Models of residential water demand were formulated using cross-sectional data. Domestic (inside) and sprinkling uses, metered, flatrate, septic tank,

supply.

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and apartment areas usage of water were differentiated. The major findings were: (1) domestic demands were relatively inelastic with respect to price; (2) sprinkling demands were elastic with respect to price, but less so in the west than in the east; (3) maximum day sprinkling demands were inelastic in the west but relatively elastic in the east. Longer term adjustments to price were empirically investigated, and the role of demand functions in pricing and system design was discussed. (Grossman-Rutgers) W68-00991

A BENEFIT-COST ANALYSIS OF LOCAL WATER SUPPLY, Louisana St. Univ., Baton Rouge, Economics Dept.

W. J. Stober and L. H. Falk.

Land Economics, Vol 43, No. 3, pp 328-335, Aug 1967. 8 p, 1 fig, 1 tab, 6 ref.

Descriptors: Investment, Economic efficiency, *Cost-benefit analysis, Return to Depreciation, *Cost-benefit analysis, Rescale, Risks, Water resources development. Identifiers: Economics, *Local governments, In-

dustrial water.

Benefit-cost analysis should determine whether a shortage of water for industrial and municipal use should be overcome by the local community or by the industrial users. The community project would be reimbursed by the sale of water. A local project may have a favorable ratio from the viewpoint of the local community but the costs to the nation may exceed national benefits. The costs to the community and to the industry were theoretically derived and a benefit-cost formula was determined. The benefit-cost ratio should be greater than one if the objective of the community is to maximize its net benefits. Such factors as returns to scale, interest rate, income tax structure, and differences in cost of capital were considered. (Grossman-Rutgers) W68-00994

HOUSEHOLD WATER USE AND SOCIAL STATUS.

Rhode Island Univ., Kingston, Agricultural Experi-

ment Sta. Irving A. Spaulding. 1967 Bulletin 392, Agricultural Experiment Station. University of Rhode Island. 36 p, 1 fig, 24 tab,

Descriptors: *Regression analysis, Sampling, *Municipal water.

Identifiers: *Social aspects, *Water utilization, Economics.

The study tested the hypothesis that quantities of water used in households are related to the social status of those households. Data used in study was acquired from a sample of households served by the same municipal water supply in Warwick. Rhode Island. Questionnaires were used, a sample questionnaire was included. A second source of data was the records of the municipal water supply. By use of regression analysis the quantity of water used per household was found to vary directly with social status. Two important variables found were house value and household income. Numerous tables of data and a frequency distribution of households studied were included. (Grossman-Rutgers) W68-00995

THE PRICE AND CONSUMPTION OF WATER FOR RESIDENTAL USE IN GEORGIA,

Georgia Univ., Athens, Dept. of Agricultural **Economics**

James E. Ware, and Ronald M. North.

Research Paper No 40, Oct 1967, Bureau of Business and Economic Research, School of Business Administration, Georgia State College, Atlanta. 19 p, 1 fig, 5 tab, 9 ref.

Descriptors: *Regression analysis, Prices, Income, Elasticity of demand, *Water demand, Acreage, Rain, Value, Air temperature, Plumbing. Identifiers: *Water utilization, Economics.

This study examined the factors that affected the demand for water by residential users in selected Georgia communities. The various uses of residential water were discussed. Regression analysis was used to measure the affect of the following variables: price of the water, family income, number of persons per household, market value of residence, state of household technology, presence of an automatic lawn sprinkler system, amount of irrigable lawn area, precipitation, temperature, humidity, and vegetation. The dependent variable was the quantity of water used per household per year. The findings were that price, the presence of a sprinkler system and/or pool, and income were the most significant variables. A linear demand func-tion and its price elasticity were estimated. A comparison of the study's results was made with other similar investigations and policy suggestions were made. (Grossman-Rutgers)

6E. Water Law and Institutions

CONSTITUTIONAL LAW - DUE PROCESS - NOTICE PROVISIONS OF WATER SUPPLY ACT CONSTITUTIONAL,

Albany Law School, Albany, N. Y. Margrethe R. Powers. Albany L. Rev, Vol. 26, No. 2, pp. 321-325, Jun. 1962. 5 p., 22 ref.

Descriptors: *New York, Legal aspects, Judicial decisions, Riparian rights, Condemnation, Eminent domain, Riparian land, Local governments, Water resources development.

Identifiers: Water Supply Act, Constitutional law, *Notice, Due process.

This is a case comment on Schroeder v City of New York, 10 N Y 2d 522, 180 N E 2d 568, 225 N Y S 2d 210 (1962), in which plaintiff's riparian rights were infringed by the construction of defendant's dam under provisions of the Water Supply Act of 1905. Plaintiff failed to apply for compensation for the taking of her riparian rights in the time provided by the statute, but she claims that the notice provisions of the act did not give her adequate notice by newspaper publication and posting of handbills along the affected watercourses. The court held such notice to be sufficient to a property owner, but the author concludes that in view of recent decisions on the adequacy of notice, the United States Supreme Court will probably hold that the notice provisions are not reasonably calculated to guarantee due process and are unconstitu-tional. (Smith-Fla) W68-00746

WHO OWNS THE WATER BOTTOMS, Louisiana State Bar Association, New Orleans. Joseph Onebane La BJ, Vol 6, No 1, pp 46-65, May 1958. 20 p.

Descriptors: *Louisiana, *Ownership of beds, Beds under water, Legal aspects, Boundaries (Property), Judicial decisions, Legislation, Bodies of water.

This article presents a detailed discussion of the ownership of bottoms of rivers, lakes, and streams in both fresh and salt water. Various legislative acts and case decisions concerning the ownership of water bottoms are analyzed at length. The major

water bottoms are analyzed at length. The major problem in this area appears to be whether the State of Louisiana ever had the power to convey title to the bottoms of certain bodies of water to private owners, and if so, whether or not this was validly accomplished. The author concludes that no definite outcome can be predicted for future cases, and each case will have to be considered on cases, and each case will have to be considered on the basis of its own merits. (Smith-Fla)

W68-00750

NORFOLK DREDGING CO V RADCLIFF MATERIALS, INC (OWNERSHIP OF BEDS). 264 F Supp 399-403 (E D Va 1967).

Descriptors: *Virginia, Riparian rights, Severance, *Ownership of beds, Remedies, Legal aspects, Judicial decisions, Navigable waters, Federal government, Federal jurisdiction, State governments, State jurisdiction, Permits, Dredging, Easements.

Plaintiff dredging company seeks damages for injury to its dredged channel allegedly caused by defendant dredging company's shell dredging operation. The court held that where plaintiff relied solely on a dredging permit from the Corps of Engineers and was not an owner of riparian property, it did not was not an owner of riparian property, it did not have a sufficient property right or interest in the channel it had dredged to maintain the suit, because the permit specifically conferred no property rights. The bottom was owned by the state of Virginia, not the federal government, and since the defendant had a contract with the state it was operating under a contractual right granted by the owner while plaintiff was not. Even if the government owned riperian rights, it did not transfer them to plaintiff by the language of the permit, and such rights are property and are transferable under Virginia law. Plaintiff has not suffered damage to personal property or to an intangible property right such as an easement or license, since only the owner of the land can grant such intangible rights. His loss does not give rise to an action for damages. (Smith-Fla) W68-00752

RIVIERA ASSOCIATION, INC V TOWN OF NORTH HEMPSTEAD (PUBLIC TRUST DOC-TRINE).

State of New York.

52 Misc 2d 575, 276 N Y S 2d 249-257 (1967).

ship of beds, *New York, *Riparian rights, Legal aspects, *Beds under water, Water law, Local governments, High water mark, Riparian land, Judicial decisions.

Identifiers: *Injunction, Public trust doctrine.

This is an action to enjoin a town from conveying land. The defendant town owned the bed of Man-hasset Bay under a colonial grant. Plaintiff owned land which fronted on Manhasset Bay. Plaintiff built a seawall and a boat slip and placed fill in front of his upland. The town advertised and sold, front of his upland. The town advertised and sold, subject to the rights, if any, of abutting upland owners', submerged land in front of plaintiff's upland, including the land the plaintiff had improved. The court held that the plaintiff had no preemptive right to purchase submerged land in front of his upland, absent a statute so providing. The public trust doctrine does not forbid the conveyance of submerged land by the town where this conveyance does not substantially impair the public interest in lands and waters remaining. The conveyance was proper even though not for public purpose. The injunction was denied. (Kirkconnell-Fla) W68-00753

SWAN LAKE WATER CORP V SUFFOLK CO WATER AUTH (WATER SUPPLY COMPANIES' AREA OF SERVICE). State of New York.

20 NY 2d 81, 228 NE 2d 773-779 NY (1967).

Descriptors: Water control, *Water works, Water delivery, New York, *Administrative agencies, *Administrative decisions, Boundaries, Water distribution (Applied), Utilities, Water management (Applied).

The parties to this case are competing water com-panies. Both are subject to the authority of the Water Resources Commission. The controversy arose over who should provide water for the Brook haven Memorial Hospital. Plaintiff already had

Field 06-WATER RESOURCES PLANNING

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water lines laid along its eastern boundary, which is a road facing the hospital. The defendant proceeded without the commission's approval to form a contract with the hospital. This was in violation of a commission order, which prohibited defendant's entering into competition with any waterworks system then legally established in the county. Defendant tried to excuse its activity as not being in competition with plaintiff, though its nearest main was 2,190 feet away and plaintiff's was just across the road. The New York Court of Appeals ruled that this controversy was fit for determination by the Water Resources Commission. This situation could clearly be viewed as competitive, and the commission should determine whether to enlarge plaintiff's boundary to include the hospital or authorize extension of defendant's main to reach the hospital. (Harriett-Fla) W68-00754

GOLOSKIE V RECORVITZ (TITLE TO RESER-VOIR BED). 219 A 2d 759-763 (R I 1966).

Descriptors: *Rhode Island, Docks, Boundaries

(Property), Judicial decisions, *Boundary disputes, Water law, Ownership of beds. Identifiers: Possessory right.

The petitioners brought a suit in equity against the respondent Recorvitz to enjoin him from maintaining and using a wharf extending into a reservoir. Petitioners claimed title to the bed on which the wharf was constructed, while respondent made no claim of title to the land in question. The Rhode Island Supreme Court, disagreeing with the holding of the trial justice that the petitioners could not recover on the weakness of the respondent's title. held, inter alia, that in such a case it is incumbent on the complaintants to prove only a right of immediate possession in themselves superior to any such right in the respondent. (Patterson-Fla) W68-00759

RIPARIAN WATER LAW - LAKESHORE DEVELOPMENTS, Law School of the U of Wisconsin, Madison.

Richard C. Glesner.

Wis L Rev, Vol 1966, No 1, pp 173-190, winter 1966. 18 p, 1 dwg, 85 ref.

Descriptors: *Riparian rights, *Wisconsin, *Lake shores, Reasonable use, Lakes, Domestic uses, Natural flow, Legislation, Regulation, Administra-Natural now, Legislation, Regulation, Administrative agencies, Water law, Judicial decisions, Relative rights, State government, Water permits, Water courses (Legal), Canals, Artificial use. Identifiers: *Lakeshore developments.

This article examines the effect of the riparian doctrine on a lakeshore development which seeks to increase the supply of waterfront property by dredging artificial canals from the lake, and developing the shores of the canals. The common riparian rights are noted. The author sets out the natural flow and reasonable use doctrines of riparian rights. (The Wisconsin courts follow the reasonable use doctrine.) The issue of whether or not the proposed development is a reasonable riparian use is discussed. The admission of excessive numbers of 'strangers' to the lake's waters, the quantity of water diverted, lowering of the lake level, and the possible overcrowding of the lake are considered. The lateral extent of riparian land is determined by either the source of title test or the unity of title test. Wisconsin legislation regulating the diversion of water is examined. This statute diversion contains elements of both the unity of title and the source of title tests for determining the lateral extent of riparian land. This article contains an extensive discussion of Wisconsin riparian law. (Kirkconnell-Fla) W68-00761

HELLIWELL V STATE (TITLE TO TIDE-LANDS).

183 So 2d 286-289 (3 DCA Fla 1966).

Descriptors: *Florida, Public lands, Navigable waters, Tides, Tidal waters, Beds, Ownership or beds, Real property, High water marsh, Tidal marshes, Marshes, Coastal marshes, Salt marshes, Swamps, Water law, Legal aspects, State govern-

Identifiers: *Sovereignty lands, Tide lands, Shore lands, Evidence.

The controversy concerned the ownership of alleged marsh or swamp lands adjacent to an island in Biscayne Bay. The plaintiff claimed title to the land through a deed conveying salt marsh and mangrove flats. The defendant, State of Florida, claimed that the land in question was sovereign in character. The Court held that the evidence was sufficient to show that the property in question consisted of tide lands, covered and uncovered by the ordinary daily tides of public navigable waters and that such land is soverign in character owned by the state. (Horner-Fla) W68-00762

TRISTATE ENTERPRISES. INC BERKOWITZ (SUBMERGED LANDS).

182 So 2d 40-44 (2d D C A Fla 1966).

Descriptors: *Florida, *Bulkheads, *Riparian land, Beds, Ownership of beds, Beds under water, Judicial decisions, Legislation, Riparian rights, Gulf of Mexico, Bulkhead lines, Boundaries (Property), Water law, Land forming, Navigable waters, Legal

Identifiers: *Mortgages, Bulkhead laws.

Appellee held a mortgage on a tract of land, the west boundary of which was the Gulf of Mexico. Subsequent to this mortgage, the owner of the land purchased adjoining submerged lands in the Gulf of Mexico from the Trustees of the Internal Improvement Fund. The owner bulkheaded and filled these lands, then subdivided and sold both upland and submerged lands. Appellants are purchasers of one of the lots located in the area of the submerged land. The trial court held that appellant's lot was subject to the mortgage. Appellants claim that title to the submerged land on which their lot is located was in the state of Florida at the time the mortgage attached to the original purchase, hence the mortgage did not attach to their land. A conveyance of riparian land includes riparian rights. The right to purchase and fill submerged lands is a valuable right appurtenant to ownership of adjoining upland. The acquired submerged land is a direct fruit of and in large measure the replacement for the appurtenant riparian rights attached to the upland which had been subjected to the mortgage. The decision of the trial court was affirmed. (Kirk connell-Fla) W68-00763

RUMFORD FALLS POWER CO V FPC (HYDROELECTRIC LICENSING).

355 F 2d 683-688 (1 Cir 1966).

Descriptors: *Federal Power Act, *Hydroelectric project licensing, *Hydroelectric plants, Water utilization, Federal Government, Water law, Navigable waters, Legal aspects, Electric power, Electric powerplants.

The petitioner applied for an antedated license to operate a hydroelectric project on navigable waters. The license contained an article which would not have been in the license had it applied at the proper time. The court held that the petitioner should not be better off than other applicants who filed on the date on which it is fact filed and it would have to accept the same license as was required of the other applicants. However, the

court held that the Commission could not properly require any applicant to accept the article in question because it was too vague. The case was remanded to the Commission to clarify the article. Horner-Fla) W68-00764

LINDSEY V CITY OF GREENVILLE (PERIODIC DAM OVERFLOW NOT A TAKING'). 146 S E 2d 863-868 (S C 1966).

Descriptors: *South Carolina, Legal aspects, Judicial decisions, Eminent domain, Floods, Rain, Water injury, *Flood damage, Discharge (Water), Reservoirs, Dams, *Excessive precipitation.

Plaintiff sought damages for the destruction of his bean crop as a result of flood waters released by the defendants in the operation of their dam and reservoir. The South Carolina Supreme Court upheld a verdict for the plaintiff, saying that the flooding and destruction of plaintiff's crop constituted a taking of his property for a public purpose for which just compensation must be paid under the South Carolina Constitution. The heavy rains which necessitated the discharge of large volumes of water from defendant's reservoir were not un-precedented and would in all probability occur again. These facts fulfill the requirement that the taking must be permanent or presumably of a permanent nature for compensation to be awarded under the provision of the constitution. The operation of the dam and reservoir was a public use, the damages resulted from the operation, so this was a taking of property for a public use for which just compensation must be paid. (Smith-Fla) W68-00765

THOMPSON V ENZ (RIPARIAN RIGHTS AND NONRIPARIAN LAND). 2 Mich App 404, 140 N W 2d 563-565 (1966).

Descriptors: *Michigan, Riparian rights, Riparian land, Legal aspects, Judicial decisions, *Severance, Articial watercourses, Boundaries (Property), Lakes, Canals.

Plaintiffs seek to prevent the defendants from granting riparian rights to lots subdivided from their land which do not touch the waters of the lake, but are to be connected to the lake by canals. The Michigan Court of Appeals held that while riparian rights cannot be created in non-riparian land, the lots in question are all parcels of riparian land and riparian rights of access to and use of the lake may be reserved by proper conveyance, even though most of the subdivided property will be longer touch the lake. In a proper case, a use which adversely affects the rights of other riparian owners will be enjoined, but that was not brought before the court by the parties. See Thompson v. Enz, 379 Mich. 667, 154 N W 2d 473 (1967), in which the Michigan Supreme Court reversed this decision. (Smith-Fla) W68-00768

HIXON V PUBLIC SERVICE COMM'N (OB-STRUCTION IN NAVIGABLE LAKE). 32 Wis 2d 606, 146 N W 2d 577-594 (1966).

Descriptors: *Administrative decisions, Adminis-Descriptors: *Administrative decisions, trative agencies, Ownership of beds, Public rights, *Riparian land. Riparian waters, *Water law, *Riparian land, Riparian waters, *Water law, Navigable waters, *Wisconsin, Judicial decisions, Breakwaters. Identifiers: Public trust doctrine.

Appellant Hixon, owner of riparian land on a navigable Wisconsin lake, constructed a break-water protruding 75 feet from the shoreline. The Wisconsin Public Service Commission had authority to order obstructions on the bed of a navigable lake to be removed if they materially obstructed navigation, reduced effective flood flow capacity, or were detrimental to the public interest. After a

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hearing was held, the commission found all three of these elements to be present, and ordered the breakwater to be removed. The plaintiff appealed on the grounds that the findings of obstruction to navigation and detriment to public interest were unsupported by substantial evidence and were arbitrary and capricious. The court held that while the State of Wisconsin holds beds of navigable waters in trust for all its citizens, the legislature may authorize limited encroachments upon beds of such waters where the public interest will be served. The legislative function of determining whether encroachments are consistent with the public trust was delegated to the commission. Since there was a reasonable basis in evidence for the commission's removal order, a court will not question its judgment. A strong dissenting opinion was filled. (Patterson-Fla) W68-00769

OLIPHANT V FRAZHO (PUBLIC TRUST DOCTRINE IN THE GREAT LAKES).
State of Michigan.

5 Mich App 319, 146 N W 2d 685-689 (1966).

Descriptors: *Michigan, *Ownership of beds, Boundaries (Property), *Public rights, Legislation, Judicial decisions, Water law, *Beds, Swamps. Identifiers: Public trust doctrine, *Great Lakes Submerged Lands Act.

The case involved a suit to adjudicate rights to enlarge a canal adjacent to lands in which the state intervened to assert its claim. The land in question was unpatented, filled bottom land of Lake St. Clair beyond the patent line. The state claimed it held the land as a public trust by virture of the Great Lakes Submerged Lands Act and another statute, which in part dedicated swamp or submerged lands along the borders of the Great Lakes for public hunting and shooting grounds and for the benefit of the people. Such lands are not held in a proprietary capacity by the state, but in trust, in a governmental capacity, for the people. Plaintiff claimed that the state should be stopped from asserting title to the disputed land by virture of delay and the fact that it had joined in the platting of subdivision that included the area. The court in the instant case rejected this argument, but noted that occupiers without title of filled-in trust lands may, under the Great Lakes Submerged Lands Act, buy such land from the state for its unimproved value. (Patterson-Fla) W68-00770

LAKE PROVIDENCE PORT COMM'N V BUNGE CORP (THE PUBLIC RIGHT AND RIVERBANK CONSTRUCTION).

193 So 2d 363-368 (Ct App La 1966).

Descriptors: *Riparian rights, *Banks, Mississippi River, Riparian land, Administrative agencies, Judicial decisions, *Louisiana, Construction, Public rights, Relative rights, Legislation, Levees, *Regulation, Right of way, Shores, Structures, Rivers, Navigable waters.

Navigable waters.
Identifiers: *Servitudes, Lake Providence Port
Comm'n, Injunction.

This was a proceeding by a port commission to enjoin a landowner from building a grain elevator on its land on the banks of a navigable river. The plaintiff Lake Providence Port Commission was created as an executive department by the Louisiana Constitution with authority over all riverfront land and development of port facilities within East Carroll Parish. Defendant corporation sought to construct a grain elevator on the riverbank between the water's edge and the levee. The commission claimed that the riparian servitude established by the Louisiana Civil Code in favor of the public prohibits defendant's construction on the 'bank' of the river. The court held that the commission had authority to regulate commerce and traffic within the port area, but it did not have authority to

prohibit reasonable use of property owned by others adjacent to the banks of navigable water. Riparian owners outside a municipality can use and develop river banks so long as use by the public is not disturbed. There is no evidence in the present case to establish that defendant's elevator would obstruct public use of the banks of the river. (Kirkconnell-Fla) W68-00771

JUZECK V HACKENSACK WATER CO (CON-DEMNATION FOR POLLUTION CONTROL). State of New Jersey.

48 N J 302, 225 A 2d 335-343 (1966).

Descriptors: *New Jersey, *Jurisdiction, *Condemnation, Judicial decisions, Water pollution control, Water policy, Administrative decisions.

The appellants, New Jersey landowners, seek review of an order of the Board of Public Utility Commissioners granting Hackensack Water Company permission to exercise condemnation power. The water company desired to condemn twenty six acres of the appellant's property, six of which would be under the waters of a reservoir, the remaining twenty acres to be used for pollution prevention purposes. The court in the instant case reversed a lower court upholding the order on the ground, inter alia, that the Water Policy and Supply Council, not the utility commission, had jurisdiction to authorize condemnation. However, the court approved of the practice of condemning more acres than would be inundated by the waters of a reservoir for pollution prevention purposes. Water purity was stated to be a pre-eminent factor in establishing the Water Policy and Supply Council, which has authority over the conservation and control of the state's waters and jurisdiction to w68-00772

SHORT BEACH COTTAGE OWNERS IMPROVEMENT ASS'N V TOWN OF STRATFORD (ACCRETION).

154 Conn 194, 224 A 2d 532-535 (1966).

Descriptors: *Accretion (Legal aspects), *Connecticut, Judicial decisions, Water law, Boundaries (Property), High water mark. Identifiers: Colonial patents.

In a suit in the nature of a declaratory judgment to determine the competing claims of the parties to the ownership of a parcel of land located at Short Beach, Connecticut, the court affirmed the finding of a referee that the town had a defensible claim to title, which the plaintiff failed to overcome, on the basis of a colonial patent. In the course of the opinion, the court stated that the owner of waterfront property is benefited in title by whatever may be joined to his land, above the high-water mark, through accretion. (Patterson-Fla) W68-00776

MCGEE V MATHEWS (AVULSION AND TITLE TO LAND).

241 F Supp 300-306 (E D Ark 1965).

Descriptors: *Arkansas, Thalweg, Rivers, Avulsion, *Boundaries (Property), *Accretion (Legal aspects). Identifiers: Government land calls.

Plaintiff McGee brought an action to quiet title to land on the concave side of an oxbow lake formed by a cutoff in the Arkansas River. The issue is whether Diamond Point, the land in dispute, was formed by a change in the Arkansas River resulting from an accretion process or from a sudden avulsion. After a thorough review of the evidence, the court found that the land was formed by accretion and held for the plaintiff. The court also held that

counties located in the thalweg of a river move with the migration of the river which comes about through the process of eroding away, passing over and filling in the area between the old and new channels, the land in issue was located in Jefferson County. Furthermore, since government land calls go out of existence when wholly engulfed by the shifting bed of the river, it follows that the tax deeds obtained by the defendants and other titles originating from lands in Lincoln County and so engulfed by the Arkansas River were invalid and of no effect. (Patterson-Fla) W68-00777

TURNER SUBDIVISION PROPERTY OWNERS ASSN V SCHNEIDER (LAKE 'BANK' AS A BOUNDARY).

144 N W 2d 848-850 (Ct App Mich 1966).

Descriptors: *Riparian land, Riparian rights, Boundaries (Property), High water mark, Easements, Lake Michigan, Meanders, Banks, Beaches, Recreation, Shores, Water law, Legal aspects, Lakes.

The question involved the meaning of language in a deed describing the defendant's lot as running in part to the bank of Lake Michigan, thence along the bank of Lake Michigan with all riparian rights pertaining thereto. The plaintiff's land was described in an earlier deed as running to the lake shore at high water and thence along the lake shore at high water. The plaintiff sought to enjoin the defendant from interfering with plaintiff's use of the beach. The defendant contended that his deed conveyed sole and exclusive ownership of the beach or in the alternative an exclusive easement over the beach. The court held that the defendant's land only extended to the bank and not to the water and the use of the term 'riparian rights' was a misnomer. Whoever owns land in contact with the water is the true riparian owner and the words 'riparian rights' in this case mean that the defendant has only an easement appurtenant for the right of enjoyment of beach uses on the land below his property. (Horner-Fla)

UNITED STATES V HARRISON COUNTY (TITLE TO ARTIFICIAL ACCRETION). 265 F Supp 76-86 (S D Miss 1967).

Descriptors: Judicial decisions, *Mississippi, *Accretion (Legal aspects), Easements, Riparian land, Littoral, Shallow water, Boundaries, Sea walls, Roads.

Harrison County constructed a seawall for the purpose of protecting an Interstate Highway from damage due to sea action. The easement for the highway and seawall was acquired from privately owned lands abutting the highway on one side and the sea on the other. After construction of the seawall the lands were washed away thereby endangering the seawall and the highway. With federal financial aid, a 300 foot wide sand beach was pumped in from adjoining shallow waters. The court held that despite the lack of participation by the owners of the abutting property in the construction of the beach, such artificial accretions inured to them under Mississippi law. No agreement had been reached between the federal government and county that the county had assumed the obligation of acquiring a recreational easement over the beach for public use. Therefore neither the state nor county acquired any right to impose such an easement, and the owners of the abutting lots owned the beach with all littoral rights incident thereto, subject only to the highway and seawall easements. (Storace-Fla) W68-00784

BURNS V WISEHEART (BULKHEAD LINES). 205 So 2d 708-710 (1st D C A Fla 1968).

Field 06-WATER RESOURCES PLANNING

Group 6E-Water Law and Institutions

Descriptors: *Florida, Legal aspects, Judicial decisions, Bulkheads, Permits, Dredging, Landfills, State Governments, Local Governments Identifiers: *Florida Bulkhead Act, *Internal Improvement Fund.

This is an action to compel the trustees of the internal improvement fund of the State of Florida to nal improvement fund of the State of Florida to give formal approval to an application for a dredge and fill permit under the Florida Bulkhead Act. The court held that where such application had been approved by the appropriate board of county commissioner, the trustees of the internal improvement fund had no discretion in granting approval of the application under the Florida Bulkhead Act. (Smith-Fla) W68-00786

THE TREND IN WATER LAW DEVELOPMENT (SURFACE WATER IN MICHIGAN), Univ. of Michigan Law School.

Jerome Maslowski.

Prospectus - A Journal of Law Reform, Vol 1, No 1, pp 131-138, Apr 1968. 8 p, 45 ref. Descriptors: *Legislation, *Michigan, Surface

waters, Great Lakes, Water law, Riparian rights, Canals, Inland waterways, Judicial decisions, Beds under water, Ownership of beds, Navigable waters, Water utilization, Regulation, Reasonable use, Public rights.

Identifiers: *Common law, *Public trust doctrine.

Statutory and common law dealing with surface waters in Michigan is examined. Surface water in Michigan is divided between the Great Lakes and inland lakes and streams. The state owns the bottom of the Great Lakes. The bottoms of inland waters are owned by riparians, with the state having a trust interest in the water itself. The state trust extends to all navigable waters. Riparians have the right to use the entire surface of the body of water for such purpose as navigation and fishing. Existing state legislation relating to ownership of water bottoms, filling, dredging, and the creation of irriga-tion districts is noted. The author concludes that a complete water code is necessary to adequately meet the increased demands of industry, recreation, and farming on the waters of the state of Michigan. Specific legislation suggested includes statutes dealing with: (1) control of upland channels; (2) a definition of navigability; (3) the use of water for irrigation. (Kirkconnell-Fla) W68-00787

NORTHWEST PAPER CO V FEDERAL POWER COMM'N (FPC DAM PERMITS).

344 F 2d 47 (8th Cir 1965).

Descriptors: *Minnesota, *Federal Power Act. *Hydroelectric project licensing, Dams, Navigable waters, Mississippi River, Permits, Licenses, Federal Government, Federal jurisdiction, Legislation, Dam construction, Structures, Administrative agencies, Administrative decisions, Hydroelectric lants, Regulation.

Identifiers: *Federal Power Commission.

This is a proceeding to review an order of the Federal Power Commission (FPC) requiring a corporation to apply for a license for continued maintenance and operation of a dam. In 1886 Congress enacted a Special Act authorizing petitioner's predecessors to construct a dam across the Mississippi River at Brainard, Minn. In 1889, pursuant to step: Note at Balliato, within the 100 parameter this Act, permittee constructed a dam across the river, In 1916-1917 petitioner reconstructed the dam to obtain a greater supply of power. In 1950 the dam was severely damaged by a flood and had to be rebuilt. The FPC has ordered petitioner to apply for a license to operate the dam as it now exists. Petitioner claims that the 1886 Special Act removes it from the jurisdiction of the FPC. The court found that the project authorized by the 1886 act no longer exists. The intent of Congress in passing the Federal Water Power Act was to bring

all water power resources under one comprehensive agency. Grants by the government are to be strictly construed in the government's favor. The 1886 act does not authorize continued maintenance of the Brainard project without a license. (Kirkconnell-Fla) W68-00789

MINNESOTA POWER AND LIGHT CO V FEDERAL POWER COMM'N (FPC PERMIT FOR WATER POWER PROJECT).

344 F 2d 53-55 (8th Cir 1965).

Descriptors: *Minnesota, *Federal Power Act, *Hydroelectric project licensing, Dams, Navigable waters, Mississippi River, Permits, Licenses, Federal government, Federal jurisdiction, Legislation, Dam construction, Structures, Administrative agencies, Administrative decisions, Hydroelectric plants, Regulation. Identifiers: *Federal Power Commission.

This is a proceeding to review and set aside an order of the Federal Power Commission requiring petitioner to file an application for a license for continued maintenance and operation of a water power project on the Mississippi River. An 1886 Special Act of Congress gave petitioner's predecessor power to construct, maintain, and operate certain structures for water power purposes on the Mississippi River at Little Falls, Minn. Pursuant to this act, the permittee constructed a dam and other structures in the river. Major structural work has been done on the original facilities subsequent to the Federal Water Power Act. The language of this act stated that the act would not affect any permit heretofore granted. The court found that this project had been substantially reconstructed and was therefore subject to Federal Power Commission control; hence the order was upheld. The dissent thought the order should be set aside, since the original Little Falls Act gave permittee power to construct, improve, maintain and develop water ower facilities. (Kirkconnell-Fla) W68-00790

TERREBONNE PARISH SCHOOL BD V TEX-ACO, INC (OWNERSHIP OF BEDS).

178 So 2d 428-437 (ct App La 1965).

Descriptors: Louisiana, *Ownership of beds, *Submerged lands, Judicial decisions, Administrative agencies, State Government, Navigable waters, *Beds under water, Navigation, Estuaries, Jurisdic-tion, Legislation, Local government, Beds, Sub-merged lands, Political aspects, Water law. Identifiers: *Mineral leases, *Sovereignty lands.

This is a suit for cancellation of a mineral lease granted by the Louisiana State Mineral Board to defendant Texaco's predecessors. This lease specifically excluded school and tax lands. Subsequent to this lease, the school board of Terrebonne Parish granted a mineral lease of the same area to someone other than defendant. Title to all lands under navigable waters passed to the state of lands under navigable waters passed to the state of Louisiana upon its admission to the Union by virtue of its sovereignty. The Louisiana Legislature granted to county school boards in trust for schools all sections of land numbered 16. The land in question is the bed of what is known as Mud Hole Bay, a body of water in a section 16. The question presented was whether the school board or the mineral board was the proper party to grant a mineral lease to the bed of Mud Hole Bay. The court found Mud Hole Bay to be navigable and that the state grant of sections 16 for school purposes did not include the beds of navigable waters, hence judgment was for defendants. (Kirkconnell-Fla) W68-00791

WATER RESOURCE DEVELOPMENT PLAN. Tri-County Regional Planning Commission, Akron,

Tri-County Regional Planning Study No. 27, April, 1963. 205 p, 18 maps, 8 illus, 20 tables, 3 charts, 3 append.

Descriptors: *Water resource development, *Watersheds, Riparian rights, Laterals, *Intergovernmental cooperation, Groundwater, Subsurface waters, *Metropolitan area planning, Water distribution, Water supply, *Multi-purpose pro-

Identifiers: Akron, Ohio, Medina County, Summit County, Ohio, Portage County, Ohio, Lake Erie.

In the Tri-county region, there is a natural limitation on available water supply. Planning for development of water resources as to yield the needed quantities must consider the lateral transfer of water across the watershed boundaries and the use of Lake Erie as a source of water. The study relates the legal background of the water status in Ohio and recommends certain revisions in the Watershed District Act; namely: (1) amending the requirement that the boundaries of a watershed district follow township lines to more closely follow the hydrologic divide; (2) combining the major river watersheds with common economic affilia-tions. The study also recommends a water policy be instituted that develops the water resources on a watershed basis. To implement the water policy the study calls for the formation of watershed districts as political entities with major responsibility for formulating plans for water improvement projects, coordinating the activities of both public and private interests in the districts, construction of water improvement projects which are beyond the capabilities of others, and, ultimately, the control of the use of water resources by requiring all projects be approved by the districts. (Starr-Chicago) W68-00844

THE ORSANCO STORY, Resources for the Future For primary bibliographic entry see Field 05D.

For abstract, see W68-00847

NEW ERA FOR AMERICA'S WATERS.

Fed Water Pollut Contr Admin Rep, 1967. 24 p.

Descriptors: Costs, Water resources, Pollution abatement, Legislation, USA, *Water pollution control, *Water quality control, Water resources development, State jurisdiction, Federal jurisdiction, Water Quality Act, Federal Government, Legal aspects, Social aspects, Conservation, Water supply 1 coal governments. supply, Local governments.
Identifiers: Clean Water Restoration Act.

This publication gives a brief resume of such areas as: (1) depletion of water resources in the United States; (2) increased and varied use of water resources; (3) industrial and municipal wastes; (4) extent of water pollution; (5) cost to clean water; (6) augmenting the water supply and (7) the role of Federal, state, and city government, industry, and individual responsibility in pollution control. Present research now in progress and legislation for control of water pollution are discussed. W68-00876

SOME PHYSICAL, TECHNOLOGICAL, AND ECONOMIC CHARACTERISTICS OF WATER AND WATER RESOURCES SYSTEMS: IMPLICATIONS FOR ADMINISTRATION,

New Mexico Univ., Albuquerque.

Blair T. Bower. Nat Res J, Vol 3, No 2, pp 215-238, Oct 1963. 24 p, 7 fig, 32 ref.

Descriptors: *Administration, Administrative agencies, Future planning (Projected), Long-term planning, Optimum development plans, *Project planning, Regional analysis, Technical feasibility, Water law, Water policy, *Water resources development, Economic cevaluation, Economics of scale, Efficiencies, Input output, analysis, Water scale, Efficiencies, Input-output analysis, Water quality control.

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The interrelations between physical, technological, economic, and administrative facets of water resources are discussed. Surface water and groundwater are found to be integrally related physically.

Quality of water is considered inseparable from quantity of water is considered inseparable from quantity of water. A water resource system is said to encompass a set of overlapping, but not necessarily coincident areas. Water resources development on the local level is found to affect planning and development on the basin or regional level and development of the basin of regional certainty existing both as to the supply and the demand for water. Larger projects are found to have a lower unit cost of output. It is concluded that an administrative agency should be set up to control water resources. This agency should be unitary and have jurisdiction over quality and quantity of ground and surface waters. It should have flexible geographic jurisdiction, and be large enough to take advantage of economies of scale. Further, the agency should be responsible for the entirer, the agency should be responsible for the entire range of outputs and for planning, design and operation of the system. (Pfeiffer-Fla) W68-00904

STREAM POLLUTION AND THE ALLEGHENY SANITARY AUTHORITY, Pittsburgh Univ., Pa. John L. Lubach, and Sanford M. Lampl.

U Pitt L Rev, Vol 10, No 3, pp 345-363, Mar 1948. 19 p, 95 ref.

Descriptors: *Pennsylvania, Legislation, *Local governments, Riparian rights, Proprietary power, Municipal wastes, *Cities, Sewage treatment, Administrative agencies. Identifiers: Sanitary Authority

The common law of Pennsylvania, as to riparian rights, and the effect of the Pollution Act of 1937 were discussed as an introduction. Pursuant to the Act, in 1945 the Sanitary Water Board ordered various municipalities and industries in Allegheny County to discontinue their discharge of untreated sewage. For this purpose, the Allegheny County Sanitary Authority was incorporated in 1946. The Authority could assume the huge initial investment in a county-wide sewage treatment system by issuing revenue bonds. Provisions were made for rate determination and for each municipality to guarantee any delinquent accounts of its residents. Possible constitutional problems were discussed, as was the method of financing the project before the plant became operative. The article predicted that upon the termination of the Authority's existence, it would convey its property to Allegheny County. Proposed legislation concerning the Authority was discussed. It was concluded that the multi-municipality authority was the most practical method of handling the pollution problems of Allegheny County. (Williams-Fla)

WATER RIGHTS LITIGATION AND LEGISLA-

TION, E. F. Taylor J Amer Water Works Assoc., Vol 59, pp 1478-1496, Nov 1967. 19 p.

Descriptors: *Legal aspects, *Riparian rights, Riparian land, *Natural flow, *Water utilization, Legislation, Political aspects, Administration, Judical decisions, Planning, Federal government, State government, River basin development, Water resources, Water pollution control, Desalination, Piver systems River systems

Identifiers: Surface flow, Regional planning.

Major judicial decisions and legislative acts concerning water rights are outlined. Litigation over riparian rights, ground water, water use, water pol-lution and surface flow is covered. State legislation concerning water use, pollution, riparian rights, and water resources is also noted, as well as federal legislation covering such areas as water resource development, water planning, reclamation, water quality standards, and federal water programs. The author surveys state and federal administrative agencies, joint interstate-federal projects, and regional water planning. (Horner-Fla) W68-00916

38 YOU SHOULD KNOW.

Stanley E. Degler. Water and Wastes Eng., Vol 4, No 1, pp 50-52, Jan 1967.3 p.

Descriptors: *Administrative agencies, *Federal government, Water law, Legislation, Water policy, Water resources development, *Regulation, Administration, Legal aspects, Administrative costs, *Government financing, Budgeting, Water supplies Pollution control.

A total of 38 federal agencies concerned with water supply and pollution control are listed, and a brief description of the function of each is given. Many of these agencies are organized under the Depart-ments of Agriculture, Commerce, Defense, Health, Education and Welfare, and Housing and Urban Development. The land and natural resources division of the Department of Justice supervises all suits and matters of a civil nature relating to water, including government cases to establish water rights, protect water resources, and abate water pollution. The division renders legal advice to federal representatives to interstate water resources compacts. The function and total funds budgeted to other federal governmental bodies concerned with water are included. (Kirkconnell-W68-00918

THE SEAWARD EXTENSION OF STATES: A BOUNDARY FOR NEW JERSEY UNDER THE SUBMERGED LANDS ACT,

Marc J. Hershman. Temp L Q, Vol 40, No 1, pp 66-101, Fall 1966. 36 p, 133 ref.

Descriptors: *Boundaries (Property), Ownership of beds, *State jurisdiction, *Submerged Lands Act, *New Jersey, Low water mark, Inlets, *Coasts, Breakwaters, Jetties, Judicial decisions. Identifiers: Convention on Territorial Sea.

The United States Supreme Court adopted the rules of the Convention on the Territorial Sea and Contiguous Zone in using the average low water line to serve as baselines from which to measure the three mile seaward limit of states' ownership of seabeds. This line should enclose permanent artificial features such as wharves, piers, jetties and breakwaters and low tide elevations within the territorial sea as measured from the permanent shoreline so they constitute part of the baseline. The baseline may be drown across bays or inlets at the protruding points of the headlands or where no protrusions exist, at points geometrically con-structed. Where state boundaries cross through bays or inlets they may be extended seaward by a perpendicular bisector of the line closing the mouth of the body of water. The seaward limit of the states' territory should be a line traced by the loci of a circle with a three mile radius when rolled along a coast line. Due to shifting coastlines a better method might be a line based on projections of future shifts so as to give stability to territorial limits. (Storace-Fla) W68-00928

PRESCRIPTIVE WATER RIGHTS IN WISCON-SIN,

Nebraska Univ. Richard S. Harnsberger. Wis L Rev, Vol 1961, No 1, pp 47-81, Jan 1961. 35

*Wisconsin, Riparian Descriptors: Prescriptors: Wisconsin, Riparian rights, Prescriptive rights, Reasonable use, Legal aspects, Judicial decisions, Legislation, Natural flow doc-trine, Water rights, *Competing uses, Relative

Under the prescriptive doctrine in Wisconsin, title to water rights may be lost by the owner and acquired by another through long continued ad-

verse use. Generally, the time required for adverse use is twenty years, and this period begins to run when acts take place which invade the rights of the party against whom an easement is claimed. Under the reasonable use theory each riparian proprietor is entitled to make beneficial use of the water, provided that it doesn't unreasonably interfere with the beneficial uses of others. When a nonbeneficial or unreasonable use is made the rights of other riparians are invaded and the prescriptive period would begin to run. To establish a prescriptive right the use must be adverse, open and notorious, under open claim of title, and continuous and uninterrupted during the prescriptive period. The extent of a prescriptive right is limited to that use made at the start of the period, and any new or enlarged use starts its own prescriptive period. Prescriptive rights may be abandoned under the general rules of abandonment. It is recommended that the doctrine of prescription be retained to keep the law flexible. (Smith-Fla) W68-00933

CONSTITUTIONAL LAW - EMINENT DOMAIN - CONDEMNATION OF RIPARIAN LANDS UNDER THE COMMERCE POWER,

George F. Lynch. Mich L Rev, Vol 55, No 2, pp 272-286, Dec 1956. 15 p, 81 ref.

Descriptors: Eminent domain, *Condemnation, Federal government, Riparian land, Riparian rights, Legal aspects, Judicial decisions, *Condemnation value, Navigation, Navigable waters, Compensation, Federal jurisdiction. Identifiers: Commerce power, Dominant servitude, lust compensation.

Just compensation.

The power of Congress to control navigation is absolute between the banks of a navigable watercourse or a non-navigable tributary thereof. All projects having any reasonable relation to the improvement of navigation are within the means of the federal government. Damage to property in or under a watercourse subject to federal jurisdiction is not a taking of private property for which just compensation must be paid, but an exercise of dominant servitude for which compensation need not be paid. Just compensation must be paid for all damage to land from a federal project found to be direct, but not for damage deemed consequential. There is said to be a 'taking' only when damage to property is permanent, and not when the damage is temporary, but the better approach would be to classify the latter as a taking also. Valuation of riparian land for just compensation cannot include the value of the possible uses the owner might have made of the water, as this stems from the dominant servitude of the water for which compensation need not be paid. (Smith-Fla) W68-00934

EMÍNENT DOMAIN - JUST COMPENSATION -FAIR MARKET VALUE - ADAPTABILITY FOR SPECIAL USE,

Phillip A. Wittmann. Tul L Rev, Vol 30, No 4, pp 593-595, Jun 1956. 3

Descriptors: *Eminent domain, Compensation, *Condemnation value, Legal aspects, Judicial decisions, Federal government, Value, Riparian land, Navigable waters, High water mark. Identifiers: Dominant servitude.

This is a case comment on United States v Twin City Power Co, 350 U S 233 (1956), in which the Supreme Court held that the value of riparian fast land (land above the high water mark) as a potential dam site is attributable to the flow of the stream, which is part of the federal government's dominant servitude on navigable waters, and is, therefore, not a factor in the valuation of that land for compensation purposes in federal condemna-tion proceedings. It is concluded by the author that previous decisions have recognized that the dominant servitude of the United States over the beds of

Field 06-WATER RESOURCES PLANNING

Group 6E-Water Law and Institutions

navigable streams does not extend to fast land, and any probable use of fast land, even though it may derive from the flow of navigable water, should be included in just compensation. (Smith-Fla) W68-00935

MUNICIPAL LIABILITY IN KENTUCKY FOR DAMAGE OCCASIONED BY SURFACE WATERS.

Cincinnati Univ., Ohio. Frederick M. Warren. U of Cin L Rev, Vol 28, No 4, pp 422-476, Fall 1959. 55 p, 189 ref.

Descriptors: *Kentucky, *Surface runoff, Precipitation excess, Rain water, Drainage water, Judicial decisions, *Cities, *Storm drains, Storm runoff, Sewers, Repulsion (Legal aspects), Civil law, Damages, Reasonable use.

Surface water is defined in the introduction. The civil law rule, common-enemy rule and the reasonable use rule are explained. A complete listing of the states which follow each rule is given. In Kentucky, as in a majority of states, it is held that a municipality's decision to construct streets is a discretionary, governmental function for which liability does not arise. However, once the city undertakes to construct streets, there is a duty to keep them safe and free from nuisance. These rules apply also to the construction and maintenance of storm sewers. Kentucky follows the civil law rule. Conclusions from Kentucky cases are: (1) A municipality will not be liable for refusal to construct sewers unless the need for them resulted from its acts; (2) If a city integrates a private sewer into its system, and damage results therefrom, liability will attach; (3) If streets and parking lots are constructed, adequate drains must be provided; (4) Sewer facilities must keep abreast of expansion; (5) A city will be liable for damage from sewers that are inadequate to handle unusual rainfalls, extraordinary or unprecedented rains, being the only defense. (Williams-Fla) W68-00937

LEVEES AND BATTURE IN THE LAW OF LOUISIANA,

Charles Schwartz, Jr.

Tul L Rev, Vol 21, No 4, pp 649-666, Jun 1947. 18 p. 84 ref.

Descriptors: *Louisiana, Levees, Beds, Legal aspects, Judicial decisions, Legislation, Compensation, Condemnation value, State governments, Floods, Administration.

Identifiers: Public servitude, Expropriation, Appropriation (Legal aspects).

The Louisiana Civil Code imposes a public servitude for the making and repairing of levees on all land adjacent to shores of navigable rivers. This servitude is not restricted to property immediately adjoining a navigable river, but is applicable to all property within the range of the reasonable necessities of a given situation, and hence varies greatly as to its extent from place to place. The Louisiana Constitution requires compensation not exceeding the assessed value of any land actually used or destroyed for levee purposes, but batture is specifically excluded. Batture, in this sense, includes land between the low and ordinary high water mark. In times of emergency neither the state nor its agencies have any responsibility for the payment of compensation for most actions taken in the interest of the public welfare to avert the situation. It is concluded that the theory of levee servitude is unadaptable to the present day system of land ownership and economic development and deletion of the concept would modernize the code, create uniformity by allowing state expropriation for right of way, and create uniformity by allowing state expropriation for right of way, and dispose of the problems of extent and administration of the servitude. (Smith-Fla) W68-00938

WATER AND WATERCOURSES--NATURAL WATERCOURSES--WHETHER LESSOR OR LAND LEASED FOR PURPOSES OF DRILLING FOR OIL MAY RECOVER FOR CORRUPTION OF WATER SUPPLY WITHOUT PROOF OF NEGLIGENCE ON PART OF LESSEE

Chi-Kent L Rev, Vol 31, No 4, pp 378-380, Sep 1953.3 p.

Descriptors: *Illinois, Saline water-fresh water in-terfaces, *Saline water intrusion, Oil wells, Groundwater, Legal aspects, Judicial decisions, Subsurface waters, Water pollution sources, Water

In the Illinois case of Phoenix v. Graham, 349 III, App. 326, 110 N. E. 2d 669 (1953), a lessor had leased part of his farm to the defendant for the purpose of mining oil and gas thereon. At the expiration of the lease the lessor sued the lesee for pollu-tion of the water supply by salt water, allegedly caused by drilling. He relied on a statute making it a public nuisance to permit salt water to escape into any underground fresh water supply. The Illinois appellate court ruled that the lessor could not recover unless he could prove negligence on the part of the lessee, and could not rely solely on the violation of the statute. The decision is criticized because the out-of-state authorities cited by the court were not on point with the facts of the present case. (Smith-Fla)
W68-00939

THE NEED FOR A NEW DRAINAGE CODE. Illinois Univ., Urbana, College of Law Harold W. Hannah.

III B J, Vol 42, No 11, pp 824-826, Jul 1954, 3 p, 1

Descriptors: *Illinois, Drainage, Drainage districts, Drainage practices, Legal aspects, Legislation, Water policy, Levees, Regulation.

The present drainage and levee laws of Illinois have become increasingly confused due to numerous amendments and court decisions. A special committee of the Section on Drainage and Levee Law of the Illinois State Bar association is working on a revision of these laws. In order to improve drainage law the committee has drafted new legislation which (1) substitutes a unified code for the present law, (2) repeals the sections providing for justice of the peace jurisdiction, (3) shifts the present sections so they provide a more logical arrangement, and (4) makes assessments and classifications for issuing bonds uniform in all districts. (Smith-Fla) W68-00940

WISCONSIN'S WATER DIVERSION LAW: A STUDY OF ADMINISTRATIVE CASE LAW,

Lee M. Modjeska. Wis L. Rev., Vol. 1959, No. 2, pp. 279-311, March 1959. 32 p, 6 tab, 82 ref.

Descriptors: *Wisconsin, Administrative agencies, Administration, *Water permits, Streamflow, Irrigation programs, *Irrigation permits, Legislation, Public rights, Riparian rights, Irrigation water, Permits, Adjudication procedure, *Administrative decisions, Relative rights, Riparian land. Identifiers: Public Service Commission

This article deals with the interpretation and application by the Public Service Commission, of the Wisconsin statutory permit system for the diversion of irrigation water from surface streams. The statute is analyzed in depth, and its procedural requirements and the problems surrounding its interpretation are explained. The Commission has held that a permit can be issued only to an owner or lessee of riparian land. The Commission follows the 'source of title' test to determine what are in fact riparian lands. Since a 1957 amendment to the statute once the riparian owner gets a permit, he may use the water on his non-riparian lands. If the diversion is of non-surplus water, consent must be obtained by all other riparians injured thereby.

Streamflow data if used to measure the proposed diversion against the available water supply. Potential injury to public rights must be considered.
Water regulation is achieved by the Commission through issuing permits containing conditions and restrictions as to rate and time of diversion and apportionment among riparians on the same stream. It is concluded that further legislation and coordination are necessary. (Williams-Fla) W68-00941

PROPOSED WATER RIGHTS LEGISLATION

IN MICHIGAN, Michigan St. Univ., E Lansing. Raleigh Barlowe

Land Economics, Vol 26, No 3, pp 300-305, August 1950. 6 p.

Descriptors: *Michigan, *Supplemental irrigation, *Water allocation (Policy), *Surface waters, Riparian rights, Legal aspects, Legislation, Prior appropriation, Reasonable use, Recreation, Riparian waters, Farm equipment, Groundwater, Judicial decisions, State governments, Irrigation permits, Irrigation.

Although supplemental irrigation has become an important farming practice in eastern states, the right of farmers to use surface and ground water for irrigation is unclear. Michigan, lacking legislation, relies on judicial decisions. The courts have applied the reasonable use rule in respect to ground waters, and the riparian doctrine in regard to surface waters. However, irrigators still assume risks: the courts have not recognized irrigation as a legal riparian use of surface water; injunctions may be issued on demand of other riparian water users; and the right to stream flow may be lost if an upstream owner appropriates the water. A proposed surface water law for Michigan is designed to meet these problems. It will provide limited modification of the riparian doctrine, allowing farmers to appropriate surplus waters for irrigation, yet preserving the vested rights of normal riparian owners. (Rives-Fla)
W68-00942

OWNERSHIP OF THE BEDS OF NAVIGABLE

LAKES, James C. Senter, Jr. Tul L Rev, Vol 21, No 3, pp 454-476, Mar 1947. 23

Descriptors: *Louisiana, *Ownership of beds, Navigable waters, Boundaries (Property), Riparian rights, *Lake beds, Lakes, Legal aspects, Judicial decisions, Legislation, State governments, Accretion (Legal aspects).

Title to the beds of navigable lakes vested in the State of Louisiana upon its admission to the Union. The policy of the state has been not to alienate the fee in beds of navigable lakes, and a constitutional provision has expressly forbidden such alienation since 1921. Prior to this time the state could legally alienate title in a navigable lake bed, and the private landowner has, under certain circum-stances, been able to acquire title to the bed of a navigable lake. Under a 1912 curative act if a person was granted a patent which included a naviga-ble lake, the state was barred from denying his ownership of the bed of the lake after 6 years. This is not applicable to patents issued after 1921. The riparian owner on lakes with a noticeable current will succeed to the alluvion formed by the accretions and derelictions of the lake, under the Louisiana Civil Code. A riparian owner on a dormant lake probably cannot acquire title to alluvion under the provisions of the Louisiana Civil Code and existing case law. (Smith-Fla) W68-00943

LEGAL FRAMEWORK OF THE INDUSTRY, NORTHERN CALIFORNIA'S WATER INDUS-

Resources for the Future Inc., Wash., D. C. Joe S. Bain, Richard E. Caves, and Julius Margolis.

Nonstructural Alternatives—Group 6F

Resources for the Future, Inc., 1966, Johns Hopkins Press, pp 59-124, 176 ref.

Descriptors: Federal-state water rights conflicts, Prescriptive rights, Administrative decisions, Appropriable waters, Riparian waters, Competing uses, Overlying proprietor. Identifiers: Northern California, *Water law.

The organization and structure of the various separate entitites which develop the water resource in Northern California is analyzed in this study. The many functions of the organizations, which include agencies of the state and federal government, local public agencies, departments of local governments. mutual water companies, privately owned firms operating under public utility regulations and a large number of individual persons or firms, are described. The development of the water resource in this region is viewed as an industry and benefitcost analysis is used to evaluate the performance of this industry. Great importance is placed upon the role of water law and reforms in existing legislation. The water law has permitted private and public agencies to acquire perpetual property rights to the agencies to acquire perpetual property rights to the use of streamflows and ground water per urban user served, with little or no restrictions. As a result of this right, a haphazard planning of water use in an inefficient manner with uneven and ineffecient allocation has taken place. Also, the state and federal authorities charged with authorizing water projects operate under vague statutory standards. projects operate under vague statutory standards and consequently do not always evaluate projects in terms of their economic desirability and feasibility or their impact upon users and uses. (Starr-Chicago) W68-00982

THE OBJECTIVES OF GOVERNMENT WATER RESOURCE POLICY, Washington Univ., St. Louis, Institute for Urban and Regional Studies. Joseph Mulholland.

Joseph Mandiana.

Institute for Urban and Regional Studies, Washington University, St. Louis, Working Paper CWR 14, August, 1967, 15 p, 30 ref.

Descriptors: *Water resources development, *Federal project policy, Cost sharing, *Costbenefit ratio, Area redevelopment, Employment

opportunities. Identifiers: Congressional action, Senate Document No. 97, *Water Resources Planning Act.

Official legislation and quasi-official pronouncement on national water resources policy are examined in an attempt to delineate the important objectives of congressional water resource policy. The historical background of water resource policy, starting with the initial federal activities in the field of flood control and river navigation, is outlined. The shift to multiple-purpose water projects after World War II operated with emphasis placed upon the criterion of economic efficiency. Senate Document No. 97 and the Water Resource Planning Act are reviewed and the shift of emphasis from economic efficiency. Io non-economic amined in an attempt to delineate the important sis from economic efficiency to non-economic goals is shown. Present policy indicated a downgrading of the benefit/cost ratio as in index for evaluating all water resource projects, and an emphasis upon economic development of a region with geographic redistribution of incomes. This present policy is based on a belief that the present distribution of incomes is socially non-optimal. An analysis of projects started by Congress in the early 1960's indicate that there are three broad interact. ing forces that motivate project selection: (1) economic efficiency; (2) income redistribution; and (3) political manipulation. (Starr-Chicago) W68-00988

RESOURCES **PROCEEDINGS** WATER SEMINAR.
Tennessee Valley Authority and Tennessee Univ.

Proc Joint Seminar Water Resour Res, Tenn Valley Auth and Univ Tenn, 1966. 114 p, 1 tab.

Descriptors: Water resources, Tennessee, *Tennessee River, *Water resources development, *Tennessee Valley Authority Project, Reservoirs, Navigation, Water pollution, Water yield, River basin development, Water Resources Research Act, Research and development, Pollution abatement. Public health.

This report contains papers presented at the First Annual Water Resources Seminar for the Tennessee Valley, held at Watts Bar Dam, Tennessee, Apr 11-13, 1966. The seminar was jointly sponsored by the University of Tennessee and the Tennessee Valley Authority. The primary object was a mutual exchange of information concerning the Tennessee Valley Authority, its programs, resources and experience, and the programs of the seven Water Resources Research Centers in the Tennessee Val-W68-01014

6F. Nonstructural **Alternatives**

WATER AND WATERCOURSES--NAVIGABILITY OF STREAMS IN MISSOURI,

U of Missouri, Columbia.

Robert S. Gardner

Mo L Rev, Vol 19, No 4, pp 401-412, Nov 1954. 12 p, 59 ref.

Descriptors: *Missouri, *Navigable rivers, Navigable waters, Riparian rights, Ownership of beds, Eminent domain, Legal aspects, Judicial decisions, Streams, Streambeds, Easements, Legislation, Non-navigable waters, Transportation.

The courts of Missouri speak of navigability of streams in two senses. In the broad sense of the term they mean that the river in question is so extensively navigable that the state retains title to the bed of the stream. In the narrow sense of the term the courts mean that navigation is not so extensive to allow the state to retain title to the bed, but there is sufficient navigation to warrant a public easement over the privately owned bed. There were early attempts by the legislature to declare certain streams navigable by statute, but it was held that this could not be done for streams which were not navigable in fact, as navigability was to be solely a judicial determination. This would be a taking of private property for public use, which can only be done by eminent domain proceedings. Only streams which are usable in their natural state can be declared navigable. To be navigable, a stream must be capable of transporting commerce in any manner in which such commerce is ordinarily con-ducted. (Smith-Fla) W68-00751

PHILADELPHIA SUB WATER CO V PENNSYL-VANIA PUB UTIL COMM'N (WATER SUPPLY COMPANIES AND THE PUBLIC INTEREST). State of Pa

208 Pa Super 93; 220 A 2d 369-373 (1966).

Descriptors: *Pennsylvania, *Utilities, *Administrative agencies, Water supply, Administrative decisions, Judicial decisions, Water users, Permits, Public benefits, Public utilities, Water works. Identifiers: *Water companies.

This proceeding involved a dispute between two This proceeding involved a dispute between two competing water companies as to the right to render service to two undeveloped tracts in Montgomery County. The Pennsylvania Public Utilities Commission granted a certificate to the Dublin Water Company to provide service to both tracts, and the Suburban Water Company appealed. One of the tracts in question is continuous to an area of the tracts in question is contiguous to an area now served by Dublin, and the other is equidistant from areas served by each of the parties. Dublin is a small company organized to provide service to an area which larger Suburban had previously found to be financially unattractive. The most important consideration in granting a certificate of public

convenience to a utility is the public interest, as distinguished from the interest of the corporation making application. The court found that the public interest would best be served by letting Dublin serve the tract continguous to its present facilities, and letting Suburban supply the other tract. (Kirkconnell-Fla) W68-00758

GREEMAN V SMITH (ACCRETION).

138 N W 2d 433-439 (N D 1965).

Descriptors: *North Dakota, *Accretion (Legal Bescriptors: "North Batota, "Activation (Legal aspects), Riparian land, Boundaries (Property), Boundary disputes, *Bank erosion, Legal aspects, Judicial decisions, Easements. Identifiers: Adverse possession

Land was riparian at the time it was originally surveyed, but it was subsequently eroded away to the extent that nonriparian land became riparian. Subsequently, land was built by accretion to the land which was originally nonriparian, extending over the location formerly occupied by the original riparian land. The North Dakota Supreme Court ruled that the owner of the land which was originally nonriparian had title only to the accreted land within the boundaries of the formerly non-riparian tract. All other accreted land extending over the area formerly occupied by the land of the original riparian owner became the property of the original riparian owner. Any land which accretes to land leased by a tenant cannot be claimed by him as owner after the period required for adverse possession, as accretion is included in any description of land to which it is appurtenant, unless an instrument shows a contrary intention. Any accretion belongs to the owner of the land, subject to any existing right of way over the bank upon which the accretions are formed. (Smith-Fla) W68-00797

ECONOMIC ANALYSIS OF ALTERNATIVE FLOOD CONTROL MEASURES,

Kentucky Univ., Lexington.

L. Douglas James. Research Report 16, Kentucky Water Resrcs Inst, Lexington, 1968, 41 p, 20 ref.

Descriptors: *Flood control, *Non-structural alternatives, Flood plains, *Flood proofing, *Land management, Project planning, Digital computers, Hydrographs, Urbanization, Landuse, Zoning, Runoff coefficient, Rainfall-runoff relationships. Identifiers: Stanford Watershed Model.

The growing realization that an effective flood control program must include non-structural measures had produced a Presidential Executive Order requiring such measures be considered by Federal agencies but created a dilemna. No methodology is available for systematic evaluation of measure combinations and prospective methodologies ap-pear too time consuming under current financial and manpower limitations. As a way out, a computer program was developed to select the op-timum combination of channel improvement, flood proofing, and land use management by location and by time within the flood plain. A second program selects the optimum detention storage in conjunction with the other measure downstream. Both programs go from raw data to a selected optimum combination of measures in one run. However, they do not produce a finished design of the selected measures. The programs have been successfully applied to four flood plains. (Author) W68-00890

RESOURCE PLANNING FOR THE CONNEC-

TICUT RIVER VALLEY, Federal Reserve Bank of Boston.

John M. Wilkinson.

Federal Reserve Bank of Boston, Report No. 39, November 1967, 175 p, 12 fig, 5 maps, 7 tab, 104

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Descriptors: *Non-structural alternatives, Flood-plain ordinance, *Water supply, *Pollution, Con-servation, Water pricing, Water management, servation, Water pricing, Wat Benefit-cost analysis, Recreation.

Identifiers: Connecticut, Massachusetts, New Hampshire, Vermont, Hartford, Conn., Springfield,

Mass., Holyoke, Mass.

By the year 2000, the 1,750,000 persons now residing in the Connecticut River Valley will have grown to 3,500,000, with more than 75 per cent of this figure living in an area which represents less than 9 per cent of the land. While many of the merging problems will probably center on the congested lower one-fourth of the river basin, the study makes a good point of the necessity of not overlooking the upper part of the basin and thereby adding to the further economic and population decline of the area. The study defines the primary problems of the basin: flooding, maintaining an adequate and unpolluted water supply and providing electric power and outdoor recreation. Multiple-means of solving these problems are offered which are alternatives to the traditional means of physical control works. Among the measures suggested as solutions to flooding are: (1) flood plain regulation; (2) flood-Formula of the control of the contro volve altering many of the institutionalized practices of the region. (Starr-Chicago) W68-00983

6G. Ecologic Impact of Water Development

WATER MAKES THE DESERT BLOOM.

Arizona Univ, Tucson. Kenneth K. Barnes. USDA Yearbook of Agr, pp 125-130, 1967.

Descriptors: Water storage, *Water utilization, Rainfall disposition, *Irrigated land, Desert plants, *Arid climates, Federal Reclamation Law, Irrigation effects, Water resources development, Storage capacity, Dams, Environmental effects, *Reclamation States, Social aspects, Crop production, Irriga-tion engineering, Water requirements.

Identifiers: Indians of North America, Salt River Valley, Ariz, Roosevelt (Theodore) Dam, Ariz,

Phoenix, Ariz

United States desert areas with less than 10 inches United States desert areas with less than 10 inches of rainfall are home to 3.5 million people. Indian irrigated agriculture disappeared from the desert around 1400 A.D. By 700 A.D. the Indians were developing a highly effective irrigated agriculture in the valleys of the Salt and Gila Rivers of Arizona. The growth of the Salt River Valley was made possible by the Reclamation Act of 1902. With the completion of the Theodore Roosevelt Dam in 1911 and the additional dams built since, the storage capacity of the system was more than 2 million acre-feet in 1966. Phoenix average annual rainfall of 7.7 inches must be augmented for crop production (ie. the water requirement for a bermuproduction (ie. the water requirement for a bermudagrass lawn is 44 inches annually). Because of the desert climate and developed water supplies for agriculture, Phoenix is a sought-out place to live and work with a population of 870,000 in 1964. (Blecker-Ariz) W68-01000

IMPACT OF LAND, WATER AND VEGETA-TION RESOURCES ON THE ECONOMY OF THE CATTLE BREEDERS OF A DESERT VIL-LAGE,

Central Arid Zone Research Institut, Jodhpur, In-

S. P. Malhotra, L. P. Bharara, and P. L. Joshi. Annals of Arid Zone, Vol 5, No 2, pp 216-228, Sept 1966. 10 p, 2 tab.

Descriptors: *Land resources, *Water resources, *Economic impact, *Vegetation, *Environmental effects, Cattle, Social impact, Rainfall intensity, Livestock, Ruminants, Goats, Domestic animals, Sheep, Water supply, Wells, Wet seasons, Arid lands, Dry seasons, Ponds, Pasture management. Identifiers: India, *Cattle breeders, Camels, Tanks, *Nomadic, Animal husbandry.

A study of the cattle breeders of a small village in Bikaner Tehsil, India, was conducted to determine how the distribution and use of land, water, and vegetation resources influenced their socio-economic conditions. The average annual rainfall was about 200 millimeters and extremely variable and erratic. Animal husbandry was the chief source of livelihood for the village. Each household had on the average 2.0 bullocks, 16.0 cows, 8.9 calves, 2.5 camels, 57.6 sheep and 8.0 goats. Sheep and goats contributed 73.7% of the total livestock in the village. The sources of water supply both for animal and human consumption were Tobas, tankas, wells, and kunds. Since the inhabitants have herds of livestock, they lead semi-nomadic lives during the rainy season and nomadic lives during acute water scarcity conditions. Most of the area around the village will go under cultivation and the area for pasture and grazing purposes will be decreased with the inception of the Rajasthan canal. (Affleck-W68-01002

07. RESOURCES DATA

7A. Network Design

OPTIMUM GAGING STATION LOCATION, U S Geological Survey, Washington, D. C Nicholas C. Matalas.

Nicholas C. Matalas.

Proc IBM Sci Computing Symp Water and Air Resources Manage, pp 85-94, Oct 1967. 10 p, 6

Descriptors: Data collections, Hydrologic data, Hydrologic properties, Correlation analysis, Net-works, Regression analysis, *Stream gages, *Opworks, Regression analysis, *Stream gages, timization, *Statistical methods, Water measure-ment, Variability, Estimating, *Gaging stations. Identifiers: Variance.

For an existing network of stations, two approaches were presented for determining an optimal scheme for gaging. Both approaches utilized the correlation for gaging. Both approaches utilized the contention between flow sequences to establish a regression relation whereby the flow properties of a discontinued station could be inferred from the properties of continuing stations. The first approach identified discontinuing stations, such that the sum of the variances of the estimates of a flow property at all stations was a minimum, subject to a budgetary constraint. Minimization of the sum of variances was shown to be equivalent to maximization of total information content. The second approach considered networks of stations for several regions, and identified discontinuing stations within each region, such that the unit cost of information was the same for all regions. The second approach was combined with a regional analysis, using regression techniques to relate mean flows at each station to the station's physiographic and meteorologic characteristics. This provided a basis for selecting additional gaging sites. (Gysi-Cornell) W68-00879

A REVIEW OF RADIOISOTOPE METHODS OF STREAM GAGING,

Australia Atomic Energy Comm, Lucas Heights, N S W, Australia For primary bibliographic entry see Field 02E. For abstract, see W68-00953

LOGGING **GROUNDWATER** HYDROLOGY, U S Geological Survey, Denver. W. Scott Keys.

Ground Water, Vol 6, No 1, pp 10-18, Jan-Feb 1968. 9 p, 8 fig, 12 ref.

Descriptors: *Logging (Recording), *Water wells, *Hydrogeology, Electrical well logging, Radioactive well logging, Boreholes, Borehole geophysics, Flowmeters, Geologic formations, Radioactivity, Subsurface investigations, Tracers. Identifiers: *Well logs, Caliper logging, Tracer in-

jection, Fluid sampling.

The uses of geophysical well-logging techniques in the exploration and development of groundwater resources is described. Of the 436,000 new water wells drilled in 1967, less than 1% were logged because of the small number of appropriate logging devices and high cost of oilfield services for water wells. The Water Resources Division of the U.S. Geological Survey is studying the application of borehole geophysics to groundwater hydrology. The tools being used and evaluated are spontaneous potential, restivity, gamma, gamma-gamma, neutron, radioactive tracer, flowmeter, caliper, fluid resistivity, temperature gradient, differential temperature, fluid sampling, and sonic velocity. Lightweight logging sondes and control modules are operated by one man. Both a vehicle-mounted logger with 6,000-ft depth capacity and a suitcasemounted 500-ft logger are being used. An inexpensive magnetic tape system was developed and is used for logrecording and playback. Logging can be used to find permeable zones, determine the best well construction methods, study lithology of the rocks penetrated, study movement of water in wells and in the ground, make stratigraphic correlations, predict yield, and determine water tempera-tures and geothermal gradients. (Knapp-USGS) W68-00968

EFFICIENT DESIGN AND UTILIZATION OF RAINFALL NETWORKS,
Georgia Institute of Technology, Atlanta.

For primary bibliographic entry see Field 02B. For abstract, see. W68-01016

USE OF ATOMIC ABSORPTION SPECTROMETRY TO STUDY THE DISTRIBUTION OF TRACE ELEMENTS IN VARIOUS HYDROLOGICAL AND GEOLOGICAL EN-

VIRONMENTS, Nevada Univ, Reno. For primary bibliographic entry see Field 02K. For abstract, see . W68-01018

7B. Data Acquisition

SOIL-WATER POTENTIAL: DIRECT MEA-SUREMENT BY A NEW TECHNIQUE, Australia, CSIRO, Division of Plant Industry, Can-berra, Aust. Cap. Territory. For primary bibliographic entry see Field 02G. W68-00699

FIELD TEST OF AN AUTOMATIC SUSPENDED-SEDIMENT PUMPING SAMPLER, Department of Agriculture, Flagstaff, Arizona, Forest Service, Rocky Mountain Forest and Range Experiment Station. For primary bibliographic entry see Field 02J. For abstract, see . W68-00703

FIELD TEST OF AN X-RAY SEDIMENT-CON-CENTRATION GAGE,

U. S. Department of Agriculture, Agr. Research Service, Soil and Water Conservation Res. Div., Sedimentation Lab., Oxford, Mississippi. For primary bibliographic entry see Field 02J. For abstract, see . W68-00720

THE PRACTICAL APPLICATION OF AERIAL PHOTOGRAPHY FOR ECOLOGICAL SURVEYS IN THE SAVANNAH REGIONS OF VEYS IN THE SAVANNAH REGIONS OF AFRICA, Hunting Technical Services, Ltd., Boreham Wood,

Herts (Great Britain).

For primary bibliographic entry see Field 021. For abstract, see .

W68-00727

THE DESIGN OF PROPORTIONAL AND THE DESIGN OF PROPORTIONAL AND LOGARITHMIC THIN-PLATE WEIRS, Bristol Univ., Dept. of Civil Engineering. W. H. H. Banks, C. R. Burch, and T. L. Shaw. J Hydraul Res, Vol 6, No 2, pp 75-106, 1968. 32 p, 8 fig, 3 plate, 16 ref, 1 append.

Descriptors: *Stream gages, *Discharge measure-ment, *Stage-discharge relations, *Weirs, Equip-ment, Instrumentation, Depth, Discharge (Water), Flowmeters, Height, Streamflow, Calibrations. Identifiers: *Sutro weirs, Proportional weirs, Logarithmic weirs, Linear weirs.

The theory of design of thin-plate weirs is summarized to list specific relations of discharge to head, to extend the approximate treatment of linear-profile weirs, and to give performance details of linear and logarithmic weirs. The effects of surface tension, viscosity, and varying approach conditions are estimated. Discharge-stage relations are developed mathematically using idealized un-contracted Bernouilli flow for proportional flow weirs, 'Eiffel tower' or concentroidal equiareal rectangular weirs, and logarithmic-profile weirs.
Sutro or modified proportional weirs and logarithmic weirs are compared theoretically and in practice. Methods are given for calculating weir profile corrections to annul observed calibration errors. Calibration procedures are developed by weighing collected discharges in tests run to verify the theoretical rating curves. Temperature variation, a major source of error, was kept under 2 deg. Head-discharge relations for the various weirs are presented graphically. (Knapp-USGS) W68-00960

PIEZOMETER FOR MONITORING RAPIDLY CHANGING PORE PRESSURES IN SATURATED CLAYS, U S Geological Survey.
Roger G. Wolff, and Harold W. Olsen.

Water Resources Res, Vol 4, No 4, pp 839-843, August 1968. 5 p, 6 fig, 5 ref.

Descriptors: *Piezometers, *Instrumentation, *Piezometry, *Water yield, Observation wells, Groundwater, Aquifers, Pressure, Aquicludes. Clays, Permeability.

Identifiers: Pore-pressure changes, Imperial College Piezometer, In situ calibration.

A rapid response piezometer used for measuring dynamic changes in pore water pressures in saturated clays in response to pumping adjacent aquifers is described. This measurement is part of a technique developed to determine quantities of water that are available from confining beds when pumping aquifers. The instrument, a modification of the Imperial College Piezometer, has rapid response, in situ calibration, high sensitivity unaffected by total pressure, rugged shock-resistant construction, and provision for continuous auto-matic recording. The piezometer was tested in clay loaded by a water column; test data are presented graphically. (Knapp-USGS) W68-00965

A SENSOR FOR WATER FLUX IN SOIL, (PART) 2--'LINE SOURCE' INSTRUMENT, Australia, CSIRO, and Australian National Univ, Canberra.

G. F. Byrne, J. E. Drummond, and C. W. Rose. Water Resources Res, Vol 4, No 3, pp 607-611, June 1968. 5 p, 3 fig, 2 ref.

Descriptors: *Instrumentation, *Flowmeters, Current meters, Thermometers, Electronic equipment, Research and development, Research equipment, Soil physics, Porous media. Identifiers: *Water flux sensor, Differential ther-

mometers, Water flux.

Two sensors are described that measure the flux of water in soil, or the flux of other fluids in any porous medium. The electrical output of such instruments can be of sufficient magnitude that a water flow velocity of .0001 cm/sec in soil is readily measured. The flow to be measured causes asymmetry in the temperature field generated by a line source of heat located centrally in the instrument. The temperature difference due to this asymmetry gives rise to the output of the instrument. A theoretical analysis of the temperature field is given for boundary conditions appropriate to each type of sensor. Theoretical and experimental calibrations agreed closely when assumptions in the theory were realized experimentally. The analysis was used to elucidate design principles and their effect on instrument performance. (Knapp-USGS) W68-00969

TWO WEIRS FOR ACCURATE STREAM-GAG-ING OF SMALL WATERSHEDS, Pennsylvania State Univ, University Park

Wade L. Nutter, and William E. Sopper. Water Resources Res, Vol 4, No 3, pp 613-618, June 1968. 6 p, 5 fig, 5 ref.

Descriptors: *Stream gages, *Weirs, *Discharge (Water), Flowmeters, Streamflow, Research and development, Small watersheds, Instrumentation. Identifiers: *Stream gaging, *Sharp-crested weirs.

Stage-discharge relationships were determined and are presented graphically for a sharp-created com-pound 30-150 deg V-notch weir, and a sharp-crested parabolic weir. Measurements were obtained from both laboratory models and field installations. Both weirs were found to be more accurate and sensitive in detecting small changes in discharge at low flows than the conventional sharpcrested 90 deg and 120 deg V-notch weirs. (Knapp-W68-00970

A VERSATILE, GAS-OPERATED WATER-LEVEL RECORDER, U S Department of Agriculture, Juneau, Alaska,

Pacific Northwest Forest and Range Experiment Station, Forest Service. A. F. Helmers.

Water Resources Res, Vol 4, No 3, pp 619-623, June 1968. 5 p, 4 fig.

Descriptors: *Instrumentation, *Water measurement, Water levels, Bubbles, Water level fluctua-Gages, Measurement, Stream gages, tion.

Piezometry. Identifiers: *Bubble gage, Gas purge, Water-level recorder.

A water-level recorder that operates by sensing pressure, as gas is bubbled freely through water, may be constructed for \$200 for cost of materials plus labor. It has been used in piezometers and precipitation gages and appears to be adaptable to recording stream stage, groundwater levels, and for other uses. Water level changes as small as 0.05 in. can be detected under laboratory conditions; probably 0.1 in. is the field sensitivity. (Knapp-USGS) W68-00971

FEASIBILITY STUDY OF QUANTITATIVE RADAR MEASUREMENT OF PRECIPITATION ON LAKE MICHIGAN,

Illinois Univ, Urbana. For primary bibliographic entry see Field 02B. For abstract, see . W68-01011

08. ENGINEERING WORKS

8A. Structures

FILL A LAKE, START AN EARTHQUAKE,

International Association of Seismology and Physics of the Earth's Interior. J. P. Rothe.

New Sci, Vol 39, No 605, pp 75-78, July 1968. 4 pp, 7 fig.

Descriptors: *Earthquakes, *Dams, *Loads (Forces), *Seismic studies, Hoover dam, Reservoirs, Water levels, Faults (Geology). Identifiers: *Earthquake-reservoir relationships, Manmade earthquakes.

The correlation of older seismic mapping with recent seismic data has made it quite clear that the construction of lake reservoirs has produced earthquakes in areas listed as free from tremors. The most noticeable recent example is the earthquake of Dec 10, 1967 at Koyna, India, which caused at least 200 deaths. The Lake Mead area on the Colorado River has no tremors in the 15 yr preceding the building of the dam; the first shock was felt in Sept 1936 when the water depth reached 100 m. In 1937, about 100 tremors were felt when the water rose to 400 ft, a load of 21,000 million tons. In 1938 seismographs were installed and recorded thousands of tremors. Recent increases in seismic frequency are correlated with dam filling in Greece, France, and Rhodesia. While the exact mechanism of earthquake production caused by loading from dam construction is not known, earthquake occurrence seems to be clearly related to the filling of lakes. (Knapp-USGS) W68-00814

DISCUSSIONS OF PRELIMINARY OPTIMIZA-TION OF AN AQUEDUCT ROUTE, Technion, Haifa, Israel; Univ of Michigan, Ann Ar-

For primary bibliographic entry see Field 06A. For abstract, see. W68-00864

FINDING RESERVOIR OPERATING RULES, Fed Water Pollut Contr Admin, U. S. Dept of the Interior, Washington, D. C. For primary bibliographic entry see Field 06A. For abstract, see . W68-00865

AN EVALUATION OF SOME GEOPHYSICAL METHODS FOR WATER EXPLORATION IN THE PIEDMONT AREA, Geological Survey of Alabama and Water Resources Research Inst, Auburn Univ, Auburn,

T. J. Joiner, J. C. Warman, and W. L. Scarbrough.

Ground Water, Vol 6, No 1, pp 19-25, Jan-Feb 1968. 7 p, 10 fig, 15 ref.

Descriptors: *Geophysics, *Magnetic studies, *Seismic studies, *Resistivity, *Subsurface mapping, Boreholes, Electrical studies, Seismology, Hydrogeology, Aquifers, Alabama, Faults (Geology), Joints (Geology), Fractures (Geology), Water wells.

Identifiers: *Geophysical water-prospecting, Seismic refraction method.

Seismic and resistivity methods were used with geologic, hydrologic, and topographic data to locate and define favorable areas for drilling water wells in the Heflin area, Cleburne County, Alabama. Groundwater occurrence in the Piedmont is controlled by topography, recharge and discharge, rock type, fracture systems, and type and thickness of saprolite. Fractures in bedrock are

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the best sources of groundwater in the area, but domestic supplies may be obtained from the saprolite. Seismic work shows that faults or fracture systems appear to coincide with depressions on bedrock surfaces. Resistivity data were used to confirm depth to bedrock determined by seismic methods and to locate gravel zones in buried stream channels. Geophysical methods are also of use in evaluating lineations or other topographic features seen on aerial photographs. Lineations may reflect faults or joints which are potential water sources. (Knapp-USGS)

ENERGY DISSIPATION FOR FLOW FROM VERTICAL CONDUITS,

Kansas State Univ, Lawrence Richard M. Haynie Proj Completion Rep, Kans State Univ, 1966. 44 p, 14 fig, 14 tab, 3 ref.

Descriptors: *Energy dissipation, Erosion, Flow, Scour, Stilling basins, Measuring instruments, Hydraulic models, Laboratory tests, *Pipes, *Conduits, *Stilling wells. Identifiers: Grid frames.

The dissipation of the energy in flow from vertical conduits is studied. A proposed energy dissipator is studied in model form. The various parameters affecting the flow were treated as variables insofar as was possible and the resulting relationships were determined. The model of the proposed energy dis-sipator structure was found to perform well. Tentative dimensions were developed for 4 different values of maximum discharge using the model results and modeling criteria. W68-01012

8B. Hydraulics

EFFECTS OF WATER TEMPERATURE ON

BED-LOAD MOVEMENT,
Waterways Exper. Sta. U. S. Army Eng., Vicksburg, Miss.

John J. Franco. ASCE Proc, J Waterways and Harbors Div, Vol 94, No. WW3, Pap 6083, pp 343-352, Aug 1968. 10 p. 8 fig, 5 ref.

Descriptors: *Sediment transport, *Flumes, *Bed load, *Water temperature, Movement, Running waters, Sediment discharge, Sediment load, Sedimentology, Tractive forces, Particle size, Sediment-water interfaces, Model studies, Thermal properties, Viscosity, Turbulent flow. Identifiers: *Sediment transport flumes, *Tempera-

ture-bed load relationships.

A movable-bed model study was performed at the Waterways Experiment Station to determine some of the effects of water temperature on the character and rate of bed-load movement. The water temperatures used in the study were 40, 60, and 80 deg F. The tests were conducted using a constant discharge, constant rate of bed feed, and constant tailwater elevation for each temperature of water, continued until the rate of extrusion of bed material and the water surface slope both became stable. Bed materials were sand with a median grain diameter of 0.23 mm, and crushed coal with a sp gr of 1.30 and a grain size range of 0.05 mm to 7 mm with a median of 2.2 mm. The rate of movement of fine sand with a rippled bed form increased with increasing temperature. The effect of temperature was greater at higher transport rates and higher energy gradients. The rate of movement of coal with a smooth bed form except for low waves increased with decreased water temperature. Increasing grain size tended to lower the water temperature at which riffles formed. The effect of water temperature on bed load appeared to be mostly in the form of the bed and in bed roughness. (Knapp-USGS) W68-00674

DETERMINATION OF DISCHARGE DURING PULSATING FLOW,

S. Geological Survey, Menlo Park, California. T. H. Thompson.

U S Geol Surv Water-Supply Paper 1869-D, pp D1-D22, 1968. 22 p, 8 fig, 8 tab, 13 ref.

Descriptors: *Streamflow, *Discharge (Water), *Stream gages, *Instrumentation, *Discharge measurement, Hydraulics, Hydrographs, Velocity, Canals, Channel flow, Flow characteristics, Open channels, Regime, Photography, Non-uniform flow, Open channel flow, Dye releases.

Identifiers: *Open-channel hydraulics, *Pulsating

flow, Depth gages, Photographic data collection, Unstable flow

Methods of determining discharge during pulsating flow were studied, and 3 methods are recommended for future instrumentation research. Conventional stream gaging does not yield valid stage-discharge relations for pulsating flow, an unstable flow regime which is characterized by a series of translatory waves moving rapidly downstream. In extreme cases, the channel may be dry between waves or the capacity of the channel may be in-adequate for an unstable flow much lower than the stable design flow. Photographic observations were made of pulsating flows developed in metered releases of 100, 200, and 300 cfs in a rectangular concrete channel of the Santa Anita Wash flood control project in Arcadia, California. Volume of waves and discharge of the non-wave part of the flow were computed separately. Satisfactory results were obtained but the method is expensive and slow. There is no theoretical basis for the technique. Data may be obtained by 3 proposed methods. The photographic and depth recorder methods measure the velocities and dimensions of the waves and basal flow separately, and discharge is computed as above by empirical methods. The constant dye-dilution method yields discharge by the ratio of dye concentrations at the injection point and a sampling site downstream. (Knapp-USGS) W68-00675

MATHEMATICAL FLOW DETERMINATION IN OPEN CHANNELS, Cornell Univ., Ithaca, N. Y.

James A. Liggett.
ASCE Proc, J Eng Mech, Vol 94, No EM4, Pap
6078, pp 947-963, Aug 1968. 16 p, 9 fig, 10 ref.

Descriptors: *Open channel flow, *Methodology, Discharge (Water), Stage-discharge relations, Backwater, Unsteady flow, Digital computers. Identifiers: *Shallow flow equations, *Three-stage method, Flow prediction.

Shallow flow equations are used with a method of characteristics that is developed and then applied to the specific problem of using stages to determine the flow quantity in an open channel. Two methods are considered which apply to channels of arbitrary cross section; one method is also valid for offstream or overbank storage conditions. These methods are intended to be general enough for use with non-prismatic, irregular channels with arbitrary inflow and outflow. A method is also presented whereby the equation can be used to determine the flow rate in a channel by 3 simultaneous stage measure-ments. It is self-checking, and can be used where stage-discharge curves fail. The 3-stage method, generally the most economical, is apparently capa-ble of predicting the discharge in an open channel from stage readings alone. Accuracy of the method is best when flow is rapid and at smaller depths, but it is reasonably accurate under backwater condi-tions where a stage-discharge relationship would fail completely. (Llaverias-USGS) W68-00815

FUNDAMENTAL FLOWS IN POROUS MEDIA, State Rivers and Water Supply Comm, Victoria, Australia C. E. Kirkham.

Bull Int Ass Sci Hydrol, Vol 13, No 2, pp 126-141, June 1968. 16 pp, 8 fig, 4 append, 4 ref

Descriptors: *Flow, *Energy equation, *Flow nets, *Energy losses, *Porous media, Laminar flow, Suberitical flow, Supercritical flow, Transition flow, Turbulent flow, Viscous flow, Darcys law, Fluid mechanics, Kinetics, Laplaces equation, Flow characteristics.

Identifiers: *Fundamental flow types, *Energy loss equation.

Several basic analytical types of flows are described using the energy loss relation s = a (v to the power n) where s = energy gradient, v = average flow velocity, a and n are parameters. The derived general flow equation is shown to give solutions for simple cases including radial, vortex, and parallel tube flows, and it may be reduced to Laplace's equation. Laminar flow is a special case with n = 1 and the solutions presented range from laminar to turbulent flow. The development of the solutions assumes orthogonality between streamlines and equi-energy lines. Methods of solutions for purely radial and purely vortex flows, the 2 fundamental components of every flow, are indicated. Worked examples show that there may be appreciable differences between laminar flownets and flownets derived from the general equation. (Knapp-USGS) W68-00833

AQUEDUCT CAPACITY UNDER AN OPTIMUM BENEFIT POLICY.

Univ of California, Los Angeles. For primary bibliographic entry see Field 06B. For abstract, see. W68-00880

THE THEORY OF ARTIFICIAL SEICHES, Cambridge Univ., Trinity College, Great Britain,

Engineering Laboratory.
A. M. Binnie.
J Hydraul Res, Vol 6, No 2, pp 107-127, 1968. 21 p, 4 fig, 1 tab, 4 ref.

Descriptors: *Seiches, *Waves (Water), *Reservoirs, *Mathematical studies, Frequency, Surges, Drawdown, Reservoir design, Equations. Identifiers: *Artificial seiches.

The artificial seiche, produced when a hydroelectric plant on a long narrow reservoir suddenly starts or stops withdrawing large quantities of water, is analyzed. Equations are presented to describe wave motion resulting both from start-up and shut-down of withdrawal in reservoirs of uniform depth and width, variable width, variable depth, and variable width and depth, assuming that width and depth increase downstream toward the dam in the variable-section reservoirs. The time waves take to travel the length of the reservoir and back is longer than the 1-node natural period in all cases except the reservoir of uniform section. The oscillation caused by shut-down in a variable-section reservoir is too complex for this kind of analysis. The calculation of seiches is important in the design of pumped-storage reservoirs, which are filled and emptied rapidly and tend to have simple shapes. (Knapp-USGS) W68-00945

SEICHES AND SET-UP ON LAKE WINNIPEG, Dept. of Transport, Winnipeg, Manitoba, Prairie Weather Central.

E. Einarsson, and A. B. Lowe. Limnol and Oceanogr, Vol 13, No 2, pp 257-271, April 1968. 15 p, 15 fig, 2 tab, 24 ref.

Descriptors: *Seiches, *Wind tides, *Hydrodynamics, Hydrographs, Regression analysis. Identifiers: *Lake Winnipeg, Canada, Geostrophic winds, Basin model.

The hydrodynamics of seiches resulting from disturbance of the surface of an enclosed body of water (Lake Winnipeg) are described in relation to

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he wind set-up. Recorder charts of water level for he iceafree season are examined for 6 stations, 961-64. Transverse and longitudinal seiches standing waves) are identified for both north and outh basins. An interference pattern is noted for eiches over 2 different fetches at Victoria Beach. Typical weather situations producing transverse and longitudinal seiches are identified. Moderate to and longitudinal seiches are identified. Moderate to arge set-up is examined for 37 cases and teostrophic winds scaled off from weather charts evering an 18-hr period preceding the peak wind et-up. Using corrections for curvature, motion of he pressure system, deviation from the main axis of the lake, and air stability, and assumed overwater componet is computed for each case. The correlation between set-up and over-water wind quare is found to be 0.81. Standard deviation of ctual set-up from that predicted by the regression quation is 0.076 m. (Llaverias-USGS)

RECONSIDERATION OF THE FLOW OF IQUIDS IN OPEN CHANNELS. Auburn Univ, Alabama

Water Resour Res Inst Proj 4, Dep Civ Eng, Au-ourn Univ, Nov 1965. 32 p, 9 fig, 1 plate, 13 ref, ppend.

Descriptors: *Hydraulic radius, *Open channel low, Geometric shapes, Cross sections, Open channels, *Rectangular conduits, Hydraulics, aboratory tests, Flumes, Hydraulic models, Anal-

This final report gives reasons for discontinuing work on the subject project. In addition, the report neludes as an appendix a M S thesis entitled Evaluation of the Validity of the Hydraulic Radius for the Analysis of Flow in Open Channels, by Neil Sadler Grigg. The thesis analyses the effect of that shape on the value of the hydraulic radius. W68-01017

8C. Hydraulic Machinery

HYDROPOWER PROJECT OUTPUT OP-TIMIZATION,

TIMIZATION, Zalifornia Univ., Berkeley. Warren A. Hall, and Theodore G. Roefs. Amer Soc Civil Eng Proc, Vol 92, No PO 1, pp 67-79, Jan 1966. 13 p, 1 fig, 5 tab, 5 ref.

Descriptors: Digital computers, *Dynamic programming, Economic efficiency, Estimated benefits, Flood control, Hydroelectric power, Hydrologic data, Optimization, Planning, Regulated flow, Reservoir operation, Water management (Applied), Pumped storage, Diversion dams, Sequential generation, Synthetic hydrology. Identifiers: Oroville-Thermalito complex Calif, Boundary conditions, Recursive relationship.

An algorithm was constructed using the recursive relationship of dynamic programming in order to find the optimal system operation for a complex hydroelectric system. The operation of nyaroelectric system. The operation of the Oroville-Thermalito complex, consisting of three reservoirs, a diversion dam, a fishlife maintenance facility, a power canal and two power generation and pumping installations, illustrated the use of the technique for a specific hydrologic period. Although an actual interval was used, any real or synthetic period could have been used. Monthly synthetic period could have been used. Monthly operations were assumed, and dependable power requirements, possible pumping periods and flood control reservations were given. Values for dependable power, generated energy, purchased energy and discount rate were given. Starting at the end of the critical period, recursive computations were made to find the optimum combination of returns from immediate release and the present value of pumpings to storage for future use. (Gysivalue of pumping to storage for future use. (Gysi-Cornell)

W68-00862

A METHOD OF SCHEDULING OPTIMUM OPERATION OF ONTARIO HYDRO'S SIR ADAM BECK-NIAGARA GENERATING STA-TION.

The Hydro-Electric Power Commission of Ontario,

Toronto, Canada.

B. Bernholtz, W. Shelson, and O. Kesner.
Trans Amer Inst Elec Eng, Vol 77, Part 3, pp 981-991, Dec 1958. 11 p, 7 fig, 9 tab, 6 ref, 1 append, 2

Descriptors: Optimization, Digital computers, *Dynamic programming, Electric power costs, Electric power demand, Forebays, Hydroelectric power, *Hydroelectric plants, *Pumped storage, Reservoir operation, *Scheduling, *Power system operations, Hydraulic properties, Discharge

Identifiers: Sir Adam Beck-Niagara, Ontario

Dynamic programming was used to schedule the optimum operation of the Sir Adam Beck-Niagara Generating Station. The complex was comprised of the main generating station with approx 300 ft head, and an auxiliary pump-generation station with a 50-80 ft head. The decision variables were the hourly discharges through the two plants. Constraints were determined by the hydraulic characteristics of the complex. The demand for power and the value of power were assumed to be deterministic functions of time. Daily scheduling was computed from 10 pm to 10 pm. The reservoir and station forebay levels were assumed to be at their minimum elevations at 10 pm. Examples of solutions. Generating Station. The complex was comprised of minimum elevations at 10 pm. Examples of solutions obtained by the use of a digital computer were shown in tables and graphs. Two discussions and a response followed the main paper. (Gysi-Cornell)

81. Fisheries Engineering

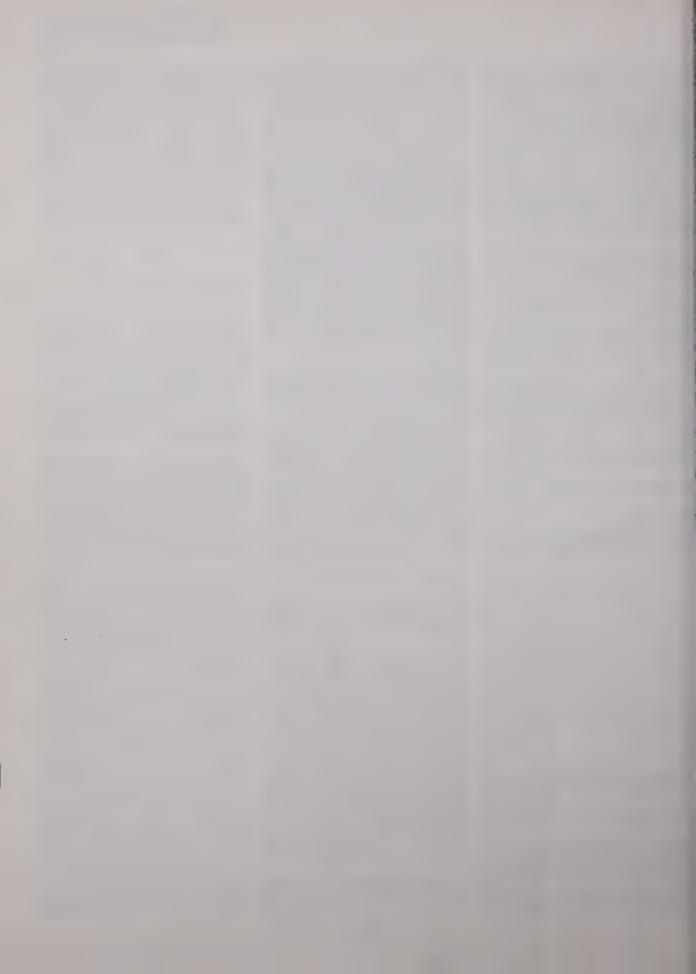
ANALYSIS OF SALMON CAPABILITIES IN STEEP FISH LADDERS,

Department of Fish and Game, State of Alaska and Alaska Univ, Institute of Water Resources, Col-

Offil L. Ziemer, and Charles E. Kehlke. Proj Completion Rep, Inst of Water Resour, Univ Alaska, Nov 1966. 13 p, 4 fig, 5 ref.

Descriptors: Energy dissipation, Fish handling facilities, Fishways, *Salmon, *Fish ladders, Cost comparisons, Hydraulic structures, Fish, Fish passages, Fish migration.

This paper presents the basic mechanics of fish passage in steep, continuous ladders and points out that the total drag force, power, and total energy requirements of the fish in passing through such ladders are each important and interrelated. The apparent limits of the continuous type of ladder are presented. Sketches of both the Alaska Steeppas Ladder and the Oregon pipe ladders are presented in the paper together with figures on those prototype ladders which have thus far proved to be successful and the provential type and the paper together with figures on those prototype ladders which have thus far proved to be successful and the paper together with the paper and the paper together th cessful passage devices. W68-01019



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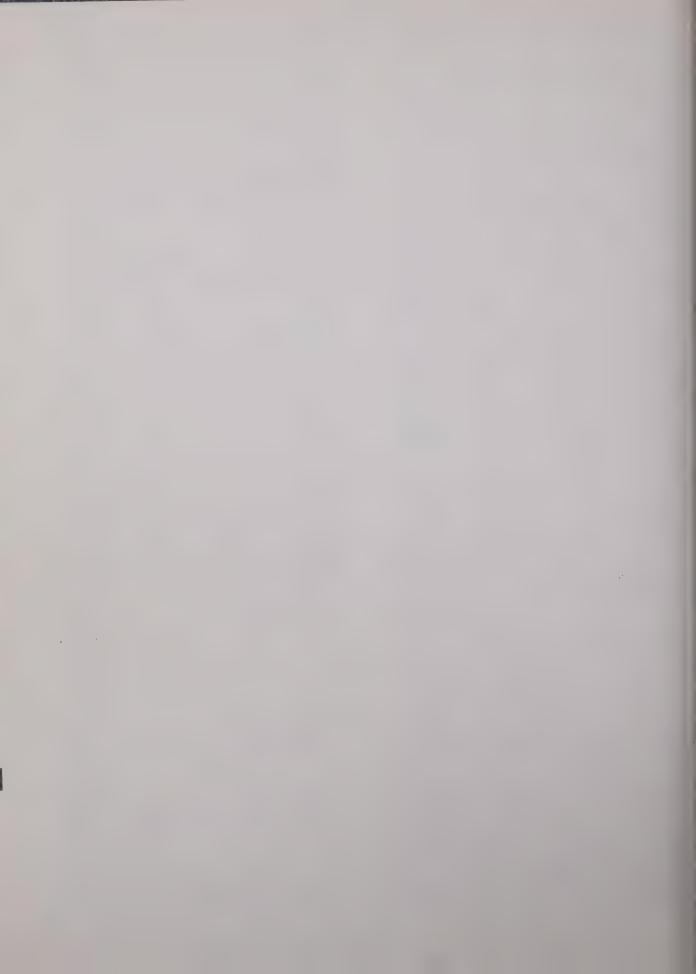
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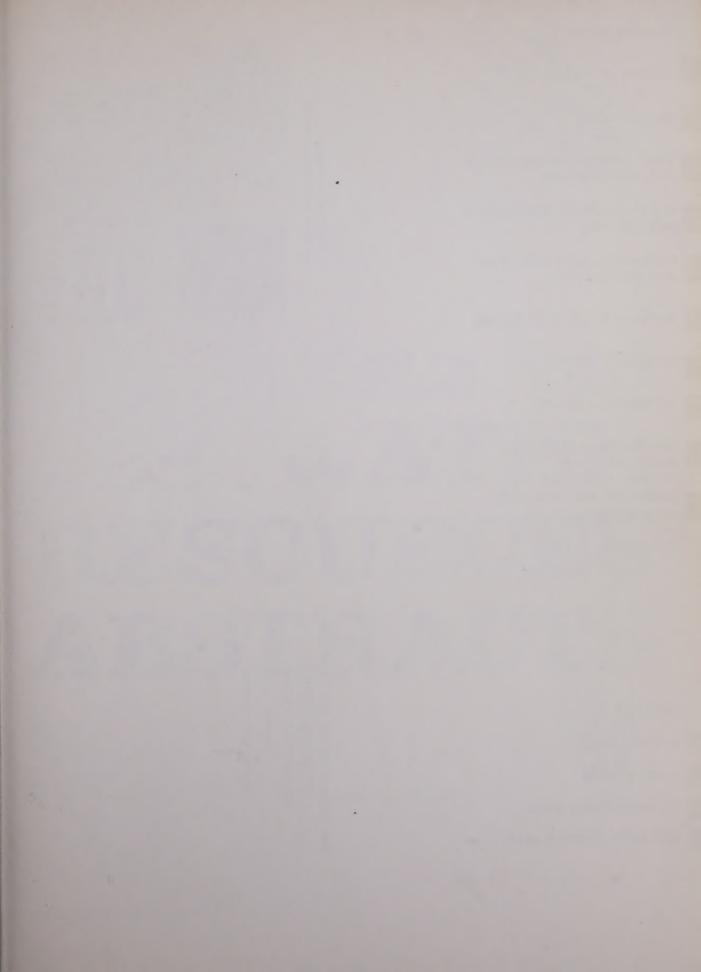
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